

# MACHINERY

January, 1909.

## DESIGN AND CONSTRUCTION OF ELECTRIC OVERHEAD CRANES—1.\*

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THE introduction and development of the electric motor, which has revolutionized so many of the methods of manufacture and transportation, has, perhaps, influenced the design of no other single auxiliary apparatus in the productive industries more than that of cranes and hoists. The present series of articles, therefore, has been written with the intention of placing on record the present practice in the design of overhead cranes, electrically operated, and of presenting such data as will aid the designer of such apparatus to properly calculate and proportion the various details, and supervise their construction.

### Overhead Travelers.

The overhead traveler in its various forms is probably in greater demand than any other type of electric crane on the market, a fact which has induced many firms to specialize in this particular branch of crane building. As a result of the continued and growing demand for these cranes, many

motor type, is in favor of the universal adoption of the latter, more especially since several makers manufacture the crabs of this type in quantities and keep them in stock, and can therefore give a quicker delivery.

One of the principal obstacles that has been placed in the way of standardizing electric cranes, is the widely varying

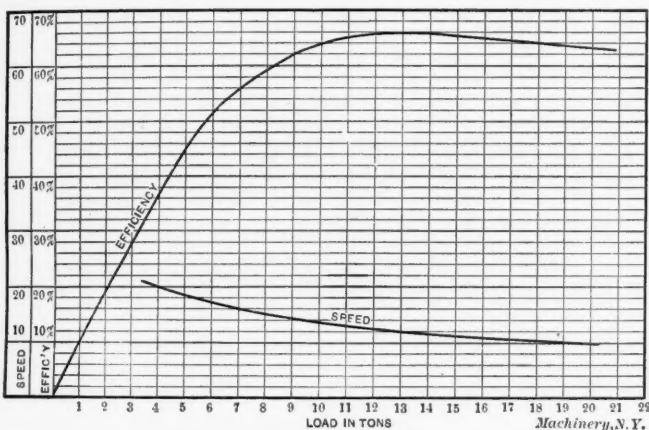


Fig. 1. Lifting Diagram for 20-ton Crane; Full Load Speed 10 feet per minute.

attempts have been made, with more or less success, to standardize, as far as possible, the various details of construction.

Electric travelers represent a type of crane which under ordinary conditions is in almost continual service, and, as with other constant working machines, it is essential that rapidity of operation, together with economy in current consumption, be preeminent factors to the purchaser and manufacturer alike. The requirements of the former should be based on the results of general experience gained during the past few years, while these results depend entirely on the skill of the designer, and the workmanship.

The three types of ordinary travelers in use are the one-motor, three-motor, and four-motor cranes. The three-motor, and for medium and heavy cranes, the four-motor types, have been found to be by far the most efficient, and are, practically speaking, the only types now used for modern workshops, warehouses, and similar localities. Until quite recently, the single motor type was considered preferable, on account of its cheapness, for engine rooms and similar places where a crane is only required occasionally. The present price of motors and their connections, and the fact that single motor cranes require more gearing than the three-

\*For previous articles on cranes, crane design, and efficiency of crane mechanism, see History of Crane Design, June, 1908; Design of Light Structural Jib Cranes, by W. H. Butz, December, 1907; Power Required for Cranes and Hoists, by Ulrich Peters, November, 1907; Formulas for Force Required to Move Crane Trolleys, by John S. Myers, October, 1907; Calculations for Shaft Gear and Bearings of Crane Motors, by George J. Leire, July, 1905; Notes on Band Brake Design, by C. F. Blake, March, 1905, and January, 1901.

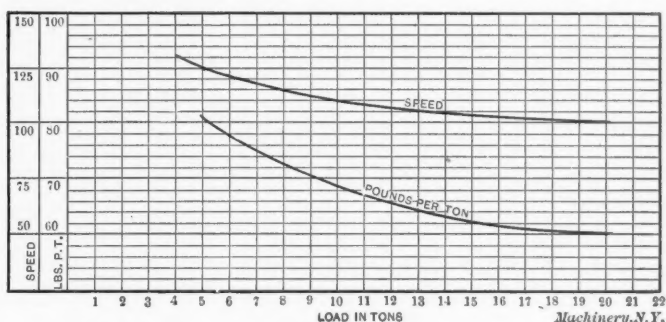


Fig. 2. Traversing Diagram for 20-ton Crane; Full Load Speed 100 feet per minute.

opinions of engineers on the question of speeds. Except for travelers which are required for work of a special nature, there is no reason why all cranes of this type should not be worked at practically the same speeds. In order to consider the conditions affecting the speed of each motion, they must be dealt with separately.

When inquiring for a crane of any type, it is usual to state the speed at which the maximum load has to be lifted; and in selecting this speed the fact should not be overlooked that, excepting the case of small powered cranes and those required for special service, the normal load is seldom more than about 20 per cent of the full capacity of the crane. It is better, therefore, to consider what is the highest and safest speed at which this normal load can be worked, and then select a full load speed which will give the same foot-tonnage of work done. By the use of crane-rated series

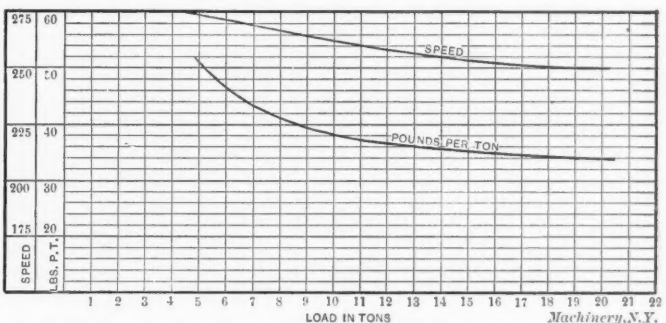


Fig. 3. Traveling Diagram for 20-ton Crane; Full Load Speed 250 feet per minute.

wound motors, a variation above the rated speed of about 50 per cent, increasing in proportion to the load, can be obtained, and this fact makes the use of change gears on the main lift unnecessary. If, however, a crane is to be used in a shop where a great deal of small material has to be constantly handled, but where a full load only occurs occasionally, as for instance, in a fitting shop, it is more economical to have an auxiliary barrel fitted onto cranes of from ten to twenty tons capacity, and worked by the main lift motor. When a light lift is required, it should be one-fifth of the full capacity of the crane, and the speed specified should be such as will give the same foot-tonnage as the main lift. Auxiliary barrels are generally placed on the main barrel pinion shaft, and so arranged that either the main pinion or the auxiliary barrel may be driven from this shaft by means of a clutch.

For cranes of twenty-five tons and upwards, that are to be in constant use, the best practice now demands an independent motor for the auxiliary barrel, the capacity of which is generally five or six tons, and the speed from twenty to thirty feet per minute.

The conditions concerning the acceleration of speed under lighter loads apply in a similar manner to traversing and traveling, and it is never worth while having a change of gear applied to these motions. The traveling speeds are a somewhat variable quantity, and cases often occur where small-powered cranes have to travel at a very high speed, as, for example, where cranes are used over pig casting beds or stock yards; when engaged in such work they may travel at a speed of 500 feet per minute, or more. For ordinary shop and similar practice the various speeds given in Table I are deduced from the modern requirements and represent an average of the speeds which have been standardized by leading makers.

In connection with the speeds in Table I., it will be necessary to explain how the horse-power required in each case has been arrived at. The horse-power of the lifting motor de-

TABLE I. SPEEDS OF ELECTRIC OVERHEAD CRANES.

Power of Crane, tons.	Lifting.		Traversing.			Traveling.						
	Speed, feet per min.	B. H. P.	Weight of Crab, tons.	Speed, feet per min.	B. H. P.	Weight of Crane.			Speed, feet per min.	B. H. P. Required.		
						30' Span, tons	50' Span, tons.	70' Span, tons.		30' Span.	50' Span.	70' Span.
3	33	10	2	120	2	7	10	14	300	5	6	7
5	20	10	2½	120	2	10	13	16	300	7	8	9
7½	20	15	3	120	3	11	14	17	300	8	9	10
10	15	15	4	100	4	12	15	18	250	9	10	11
15	12	18	4½	100	5	14	16	21	250	12	13	14
20	10	20	5	100	6	16	17	23	250	14	15	16
25	10	25	5½	80	6	19	21	26	200	14	15	16
30	10	30	6	80	8	21	25	31	200	15	18	20
40	7½	30	8	80	10	25	34	43	200	20	23	25
50	6	30	12	60	10	32	39	48	150	20	23	25
60	5	30	16	60	12	....	44	58	150	....	26	28
75	5	38	20	60	12	....	50	70	150	....	32	36
100	5	50	28	60	16	....	70	80	150	....	40	42
120	5	60	32	60	20	....	80	95	150	....	45	50
150	5	75	38	40	20	....	90	105	150	....	55	60

pends purely on the work done on the load, and the power absorbed in the resulting friction of the gearing, journals, and pulleys. This quantity varies to some extent with the number of reductions and the type of gearing. The efficiency of a crane is generally lowest at the test, improving somewhat as the journals and teeth get bedded down. The efficiency of the first or motor reduction with well-made machine cut spur gears running in an oil bath, has been found by trial to reach as much as 97 per cent, and may be taken at 95 per cent under ordinary practical conditions.

The average efficiency of one reduction of cut spur gears, running dry, is 92 or 93 per cent, and of cast spur gears running dry, 90 per cent. The loss due to journal friction is generally about 2 per cent for each axle when properly lubricated. The only other loss in efficiency of any importance is in the snatch block, if there is one fitted to the crane. This quantity is always reduced by using large pulleys and, preferably, small hardened pins, the pulleys being bushed with gun-metal, under which condition the efficiency works out to about 97 per cent.

From the above results a very fair idea of the over-all mechanical efficiency of a crane can be determined, if the number of reductions and the other particulars are known. It will be found that small high speed cranes have a higher efficiency than the larger ones, owing to there being less gearing; thus, in the case of a crab lifting three tons on a single rope and having two reductions of machine cut gearing, the first of which runs in oil, the overall efficiency will be

about  $\frac{95 \times 92 \times 98 \times 98}{100} = 84$  per cent.

For a contrary example take a 50-ton crab having four reductions, the first three of which are machine cut, the motor reduction running in oil. Then the overall efficiency will be

about  $\frac{95 \times 93 \times 93 \times 90 \times 98^4 \times 97}{100} = 66$  per cent.

A very common rule in practice is to allow ten foot-tons of work done at the hook per brake horse-power, this factor being equivalent to a mechanical efficiency of about 66 per cent. This constant is practically correct for medium and large cranes, but for small sizes it allows for a slightly larger motor than is really necessary, which is perhaps a good fault, since small cranes are generally in constant use. The above calculations are not, generally speaking, necessary in practice, but have been made in order to show how and where the power due to friction is principally absorbed, and it will be seen that the results agree very closely with the diagrams shown in Fig. 1, which are made from trials taken from overhead cranes, representing the best class of design and workmanship. It is usual and more instructive to speak of the gross efficiency of a crane, that is the combined electrical efficiency of motor and wiring, and the mechanical efficiency of the gearing, or in other words, the ratio between current consumed at the switchboard and work done at the hook. This is the efficiency as shown by the diagrams.

The electrical efficiency of a lifting motor may generally be taken at 80 per cent, covering motor and wiring, so that in the case of the 3-ton crane exemplified above, the

gross efficiency would be about  $\frac{84 \times 80}{100} = 67$  per cent. Sim-

ilarly, the 50-ton crab would give a gross efficiency of  $\frac{66 \times 80}{100} = 53$  per cent. Both of these quantities agree with

actual results.

The horse-power, or current required for each motion, as given in Table I, is the calculated power based on the

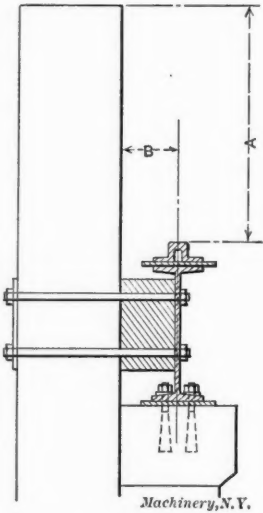


TABLE II. CLEARANCE SPACE REQUIRED FOR OVERHEAD CRANES.

Size of Crane.	A		B
	Tons.	Ft. Ins.	Inches.
3	5	0	7
5	5	6	7
7½	5	6	7
10	5	9	7½
15	6	0	7½
20	6	0	8
25	6	6	8
30	7	0	9
40	8	0	9
50	8	6	10
60	9	0	10
75	9	6	10
100	10	0	12
120	12	0	12
150	12	0	12

above described coefficients; for practical purposes, however, the nearest manufactured size of motor would be used. The power required for traversing and traveling must be sufficient to overcome the rolling and axle friction, and the friction of the intermediate driving gear. The horse-power of these motors is generally based upon a certain tractive resistance, usually expressed in so many pounds per ton of rolling load. This is a very variable quantity, even the results of tests showing a remarkable latitude. Although it is best to work with data obtained from experiments, it will be well to show the calculations which most nearly agree with actual results.

The axle friction  $\mu$  depends to some extent on the lubricating arrangements, but in the calculations it is assumed that these conditions are well provided for, both in traversing and traveling. The power required is figured from the formula

$$P = (\mu r) \frac{W}{R}$$

where  $W$  = load in pounds,  
 $R$  = radius of wheel in inches,  
 $r$  = radius of axle in inches,  
 $\mu$  = coefficient of friction = 0.10.

The rolling friction of metal wheels on steel rails is considered to be equal to  $0.002 \frac{W}{R}$ . This quantity may, therefore, be combined with the above quantity and the result obtained direct, thus

$$(\mu r + 0.002) \frac{W}{R}$$

Take for example a 30-ton crab weighing six tons, having runners 18 inches in diameter, and axles  $4\frac{1}{2}$  inches in diameter. The combined axle and rolling friction will be

$$(0.1 \times 2.25 + 0.002) \times \frac{36 \times 2,240}{9} = 2,034 \text{ pounds.}$$

The efficiency of the driving gear can be found in the same manner as described for the lifting gear, when the number of reductions are known. In the present example there would be three reductions of machine cut gears, all running dry, the total efficiency of which would be about

$$\frac{92 \times 92 \times 92 \times 98 \times 98}{100} = 75 \text{ per cent.}$$

Taking the full load speed at 60 feet per minute, it will be found that the brake horse-power required will be

$$\frac{2,034 \times 60 \times 100}{33,000 \times 75} = 5 \text{ B. H. P.}$$

The axle friction of the traveling gear will always be found to be considerably less than that of the traversing motion, due to the fact that the crab axle diameter is often larger than the main axle, while the runners are usually only half as large, and the resistance varies in proportion to the ratio of these quantities, as will be seen from the above formula. When assuming the efficiency of the driving gear for the traveling motion, some special allowance should be made for the loss of power due to the cross shaft. This shaft is carried by several bearings, and it is probably the deflection of the girders, and the consequent slight bending of the shaft, that causes the drive to be rather inefficient.

No direct results concerning this shaft are available, but its efficiency will probably be about 90 per cent for cranes of moderate span. Allowing for two reductions of machine cut gears running dry, the efficiency of this drive will, therefore, be about

$$\frac{92 \times 92 \times 90}{100} = 76 \text{ per cent.}$$

Suppose for example, that a 30-ton crane traveler weighs 25 tons, and runs upon wheels 30 inches in diameter having 4-inch axles; then the combined rolling and axle friction will be, as in the case of the crab,

$$(0.1 \times 2 + 0.002) \times \frac{55 \times 2,240}{15} = 1,659 \text{ pounds.}$$

Taking the traveling speed at 150 feet per minute, and neglecting acceleration which may, for ordinary speeds, be assumed as taken care of by the coefficient of friction and the overload of the motor permissible, the brake horse-power required will be

$$\frac{1,659 \times 150 \times 100}{33,000 \times 76} = 10 \text{ B. H. P.}$$

The resistance to traction, as nominally referred to, which this power covers will be

$$\frac{10 \times 33,000}{150 \times 55} = 40 \text{ pounds per ton.}$$

Similarly the 5 B. H. P. motor for traversing allows for 76 pounds per ton. For practical purposes 40 to 50 and 60 to 70 pounds per ton have been allowed for the best class of travelers having large diameter wheels and machine cut gears. Some tests have shown that a higher factor than 70 pounds per ton is required for traversing, such results possibly be-

ing due to the fact that the lubrication was inefficient; the traveling wheels also are often too small. The diagrams in Figs. 2 and 3 show actual results obtained in the traversing and traveling motions of cranes.

Before concluding this installment on preliminary considerations, it is advisable to call the architect's attention to the importance of allowing an adequate working space for travelers when designing shops, etc. Due to overlooking this fact, the first cost is often considerably increased, while the crane is generally of inefficient design and unsightly appearance. The dimensions given in Table II have been taken from actual practice, and will be a guide to those designing new buildings. The headroom given in this table is the least possible with an ordinary type of crab, some designs requiring rather more space. Table II shows a simple form of attachment for track girders, which has been found to answer very well for cranes up to 30 tons, and possesses the merits of being easily adjusted and inexpensive.

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### PRODUCING BLACK NICKEL COATINGS ON METAL SURFACES.

The following solution for depositing a black nickel coating on metal surfaces is given by the *Brass World*. The solution consists of the following constituents: water, one gallon; double nickel salts, 8 ounces; ammonium sulphocyanate, 2 ounces; zinc sulphate, 1 ounce. If the zinc sulphate is not in the form of white crystals, but is white and dry, then only one-half ounce should be used. The double nickel salts are dissolved in the water, and then the ammonium sulphocyanate is added. After this has been done, the zinc sulphate is introduced. The solution is used at its ordinary temperature, but in winter should not be allowed to get colder than 60 degrees F., and works best at about 80 degrees F. Ordinary nickel anodes are employed, with a surface several times that of the work to be plated. The work is cleaned carefully, preparatory to the plating. The black nickel deposit may be put directly on steel, brass, copper, German silver, or bronze, but it is preferable to first flash the work in a hot copper solution, then in a white nickel solution, and finally deposit the black nickel. For cheap work, the copper and white nickel deposits may be dispensed with, but the black nickel is less apt to peel off if put on the white nickel. The black nickel is deposited with a weak current. Best results are obtained with a current from  $\frac{1}{2}$  to  $\frac{3}{4}$  of a volt.

The deposition should be allowed to stand for an hour or more if a heavy deposit is desired. When the article comes from the black nickel solution, it will be found that it is of a gray or brown shade. While this disappears to a considerable extent when lacquered, the color is not a dead black. By using a dip consisting of one gallon of water, twelve ounces of iron perchloride, and one ounce of muriatic acid, a dead black color is produced. All nickel deposits should be lacquered after dipping.

The following causes of difficulties should be guarded against: If the black nickel deposit has spear-shaped markings on it and is partly white, too high a voltage has been used. If the deposit flakes off after standing for some time, too strong a current has been used, or the work has not been clean. If the deposit is too heavy, it is also apt to flake off. If the deposit is still brown or gray after it comes from the dip, the dip is old, or the article has not remained in the dip long enough. If, although the voltage is right (less than one volt), the deposit is streaked, the bath has become acid; add carbonate of nickel (plastic) to neutralize the acid. Use plenty of anode surface and old nickel anodes if possible. If the edges of the deposit are removed in the dip, the dip is too hot, or the black nickel was not deposited a sufficiently long time. If the surface is iridescent after lacquering, the lacquer is too thin.

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Statistics dealing with the iron industry of the world show that, during 1907, the United States produced about 43 per cent of the total pig-iron and 45 per cent of the total amount of steel produced in the world. Germany takes second place with, respectively, 22 and 24 per cent. Great Britain comes in the third place with 17 and 12 per cent, respectively.

## INDUSTRIAL PHOTOGRAPHY.\*

The first aim of the photographer of machines and industrial subjects, in general, intended for half-tone reproduction in catalogues and trade journals, should be to produce prints that will require the least retouching when used for making half-tones, and this for two reasons: First, the retouching of prints for half-tone work is quite expensive; and second, the print that requires the least retouching gives much the best results in the finished half-tone. The photographs from which the half-tones in this article have been reproduced were not retouched at all.

Nearly all industrial establishments are equipped with a photographic outfit of some kind, and in some instances an experienced photographer is in charge; but in the majority of cases one of the draftsmen must take care of all the photographic work of the establishment, and it is in the hope of aiding some of the latter that the author prepared the paper abstracted.

## Apparatus.

The camera should be a strong and serviceable one having a long bellows with very little cone. In fact, one with a perfectly straight bellows is best, as it allows greater adjustment of the lens board without danger of the bellows folds cutting off any of the object. The vertical and side swings should be ample. The camera need not be larger than  $6\frac{1}{2}$  by  $8\frac{1}{2}$  inches, and should not be larger than 8 by 10 inches, as

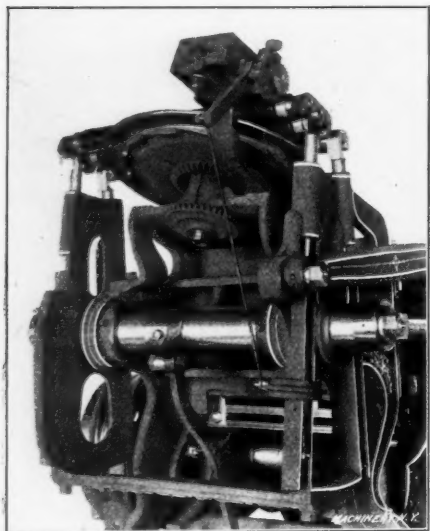


Fig. 1. Details Brought Out, and Deep Shadows Avoided by Preparation of Machine Parts before Photographing—No Retouching made on Photograph.

anything over this size is cumbersome to handle, and requires a very expensive lens and a great deal of skill to operate. If large prints are wanted, bromide enlargements can be made up to any reasonable size, and if for any reason large direct or contact prints are wanted, a slightly enlarged positive can be made from the negative, and a negative as large as wanted can be made from the positive. This procedure has its advantages, as it is often possible to correct in a great measure any errors in exposure or development, and many errors in lighting and position.

The tripod should be solid and stiff with the fewest possible joints. The lens should be the best obtainable, and too great emphasis cannot be placed on its being of long focus. Never under any circumstances should its focus be shorter than the diagonal of the largest plate with which it is to be used. It should be capable of rendering sharp definition from corner to corner of the plate when using a comparatively large diaphragm. The plates should not be the most rapid made, as the emulsion with which these are coated is not generally rich enough in silver to give printing density for anything but portrait work, and also because the timing of the exposure must be very exact. Plates of medium speed are the best and should be of the kind known as "double coated" or "non-halation."

If interior views are to be made where windows and other

\*Abstract of paper by Mr. S. Ashton Hand, read before the American Society of Mechanical Engineers, December, 1908.

openings to the light have to be faced, then the plates should be coated on the back with a compound known as "backing." This "backing" should be washed off with a damp sponge before development.

## Preparation of the Subject.

If a machine is to be photographed, it should be painted with a finishing coat of drab paint, which may be designated as "mouse color," and the paint should be so mixed as to dry absolutely "flat," that is, without any gloss whatever. If parts underneath the machine or in shadow are wanted to be shown, they should be painted a lighter shade than the more prominent parts, and the deeper they are in shadow the lighter they should be painted; in extreme cases even blending the color gradually into a white. All brightly polished parts should be daubed or rubbed over with a handful of soft putty to dull the brightness. Unless these precautions are taken, the parts in shadow will show very dark in the photograph, and if very close together will be seen only as one shapeless mass, and the bright spots will show chalky white with very black lines and little or no detail. If letters or figures cast on any part of the machine are wanted to be shown, daub them with white paint from the end of a finger. Rubbing with chalk will give them a very rough appearance.

It must be borne in mind that all high lights and shadows are greatly intensified in photography, and that a sensitive plate that will register all the gradation of tone as seen by

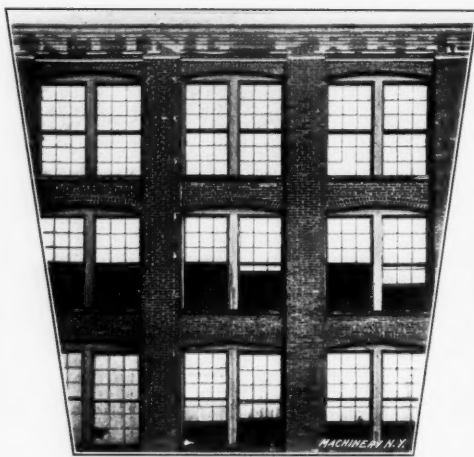


Fig. 2. Distorted View in Fig. 3 corrected in Reproduction.



Fig. 3. Distorted View caused by Pointing Camera upwards.

the human eye has yet to be made. Fig. 1 is an illustration of a machine that was properly prepared for being photographed. If possible it is best to photograph a machine before it has been run, otherwise oil from the bearings will seep out on the paint and leave dark and glossy spots which will look bad in the photograph. If the machine is to be run before being photographed, then it should not have its finishing coat until after the run or test is over. Before the finishing coat is put on, all the bearings should be thoroughly flushed with gasoline and the whole exterior cleaned with the same stuff to remove all oil.

## Lighting and Position.

Machinery should never be photographed out-of-doors or under a skylight, as there is too strong a top light, which causes deep shadows. The light should preferably come from the north, and should fall on the machine at a downward angle of about 20 degrees from the horizontal. Cross lights from other windows should be avoided by pulling down the shades or tacking up heavy paper. Cross lights make a confusion of shadows and obliterate certain lines, giving the machine anything but a natural appearance. If necessary to photograph the machine by other than northern lighting, then make the exposure when the sun is overhead. If the exposure must be made when the sun is shining through the windows at any considerable slant, tack cheese cloth over the windows to diffuse the light.

A machine should never be photographed directly from the front, which will make it appear too flat. For depth, the camera should be placed enough out of center to show a little of one side of the machine and high enough to show a little of the top. A background of heavy drilling, either white or very light in color, should be hung not less than 6 feet back of the machine. It should be of ample size—large enough so that the camera can be moved where wanted and still show

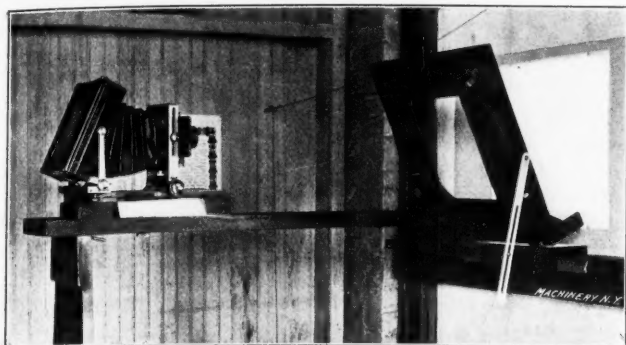


Fig. 4. Camera and Negative Holder arranged so as to correct Distortion shown in Fig. 3.

the background behind every part of the machine. If there are folds or wrinkles in the background, have a man at each side take hold of the edges and shake the curtain slowly and gently during the whole time of the exposure. This will prevent the folds or wrinkles from showing in the photograph.

Shop floors are dark in color, and if a machine is photographed directly on the floor it is often puzzling to know where the lower part of the machine ends and the floor begins. Therefore a floor cloth of the same color and width as the background should be used. It should be deep enough to extend from 4 to 6 feet in front of the machine and under it and to the background. Instead of a floor cloth, sheets or strips of light colored paper can be used, but be sure there is no pronounced red or yellow, as such colors are non-actinic and will show black in the photograph.

#### Focusing.

Never focus on the center of the ground glass, as this will give you the point of sharpest focus of the lens, and what is wanted is the average focus; therefore focus at a position

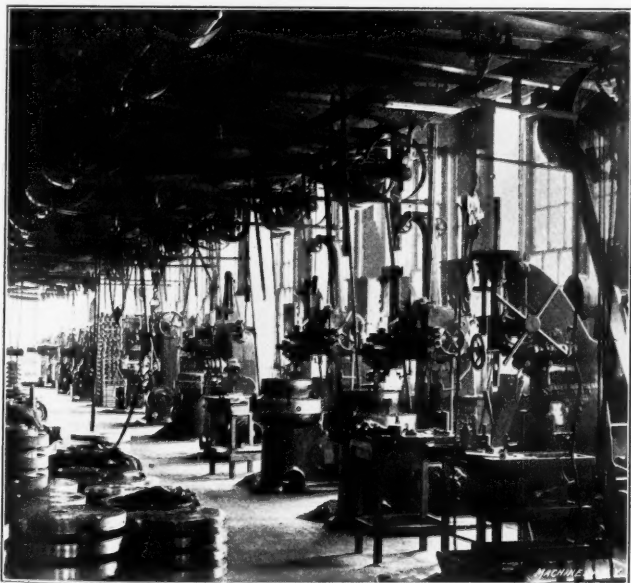


Fig. 5. Photograph taken without Special Precautions against Strong Light in the Background.

midway between the center and the edges of the ground glass. Get the nearest parts of the machine in focus. Small diaphragms will sharpen up the distant parts. Sometimes a better effect can be obtained by pointing the camera slightly downward, but if at any time the camera is used in any other than a level position, the ground glass should be brought to a vertical position, otherwise the result will be distorted lines. Fig. 3 shows a distorted view of a part of the side of a building, made by pointing the camera upward. If the

photograph of a machine shows such distortion, and for any reason it cannot be photographed again, a negative can be reproduced eliminating the distortion, by placing the negative in a frame tilted at such an angle that the narrowest lines are nearest the lens, and making a positive in the camera, tilting the ground glass at an equal angle, but in the opposite direction. A negative can be made from this positive, as shown in Fig. 2, which was actually made from a negative reproduced in the above manner from that used for Fig. 3. Notice how much the top of the negative had to be enlarged to bring the lines parallel. Fig. 4 shows a camera and negative holder in the proper position for this operation.

If the machine to be photographed is a long one, requiring a raking view, use the horizontal swing to bring that part of the ground glass on which the image of the farthest part of the machine appears, farthest away from the lens. This will even up the focus and make it possible to use a larger diaphragm, shortening the time of exposure, and also extend the vanishing point to a greater distance, giving it a more normal perspective. If there are perceptible vibrations to the floor on which the photographing is done, get three pieces of harness felt  $\frac{1}{2}$  inch thick, and two or three inches square.

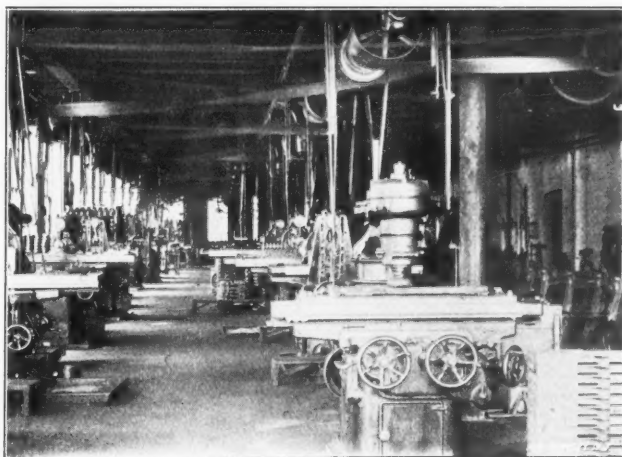


Fig. 6. Same Interior as in Fig. 5, but taken with Strong Light in Foreground.

Place one of these on the floor under each leg of the tripod, and they will absorb all ordinary vibrations and keep the camera steady.

#### Exposure.

Exposures should always be ample, as an under-exposed plate can never be made to show that which the light has not impressed upon it (although it can be greatly helped by skillful development), but a moderately over-exposed plate can easily be treated in development, or even afterwards, so as to yield a first-class print. If in doubt as to the correct time of exposure, make a guess as near as possible. Suppose your guess to be four minutes, then put a loaded plate holder in the camera and draw the slide so as to expose two inches of the plate and make an exposure of two minutes; cap the lens, draw the slide out two inches more, and make another exposure of two minutes. Repeat this, drawing the slide two inches at a time, until the whole plate has been exposed. If the plate is 8 by 10 inches, there will be five parts, having respective exposures of 10, 8, 6, 4, and 2 minutes each. Develop this plate, and it will be easy to tell which part has had the proper exposure, and from the position of this part the time can readily be found.

#### Interiors.

In photographing interiors, avoid pointing the camera towards windows if possible, but if this cannot be avoided, then cover the windows with heavy drilling or thick wrapping paper, fastening it well around the edges, so that no bright margins of light are visible. After the exposure has been made, the window coverings can be removed and an additional exposure of a fraction of a second can be given. This will give the windows a natural appearance and will often show objects on the outside. Interiors can be photographed without these precautions, but skillful work will be required to make good negatives.

Figs. 5 and 6 were made on a very bright day when snow was on the ground, and the light coming in the windows was intensely white. As the negatives were wanted in a hurry, no precautions were taken to soften or keep out the light at the windows. The far end of Fig. 5 was a southern exposure, and the sunlight was streaming in at the windows. Fig. 6 is a view in the same room taken from the south end, where the light was so intense that the milling machine in the foreground appears light in color, although it was painted a dark steel color.

#### Copying.

In copying drawings or other subjects in black and white, it is necessary to use a very slow plate, give the shortest possible exposure, and use a concentrated and well-restrained developer. If a copy is to be made from a blue print, it will be necessary to bleach the print in a weak solution of ammonia and water, and after a thorough washing, to immerse it in a weak solution of tannic acid. The part that was formerly blue will now be a rich purplish brown.

#### Enlarging Negatives.

A negative can be reproduced in a larger size by first making a positive in the copying camera, and then making a large negative from the positive by the use of the same instrument. If a negative is enlarged to many times its original size, a granular effect will be noticed. This is caused by magnification of the emulsion structure which is made up of countless thousands of hills and valleys. This granular effect can be eliminated by slightly over-exposing and greatly over-developing the original negative, and then reducing it

off, leaving the worm-wheel and the clutch collar exposed to view. The worm and shaft were removed from the upper part of the case and placed in their proper position in relation to the worm-wheel, as shown in Fig. 7. A dark background was placed in the rear and an exposure was made. After the exposure the cap was put on the lens, the worm and shaft taken away, and the upper part of the case put in position as in Fig. 8. A light background was substituted for the dark one, and another exposure made on the same plate, the result of which is shown in Fig. 9.

#### Development.

Of the art of development much has been written, and more has been said, but the fact remains that the only adequate teacher is experience. After many years of experience, the author of the paper abstracted hesitates to attempt to tell in writing how to handle a sensitive plate in development. A few hints, however, concerning the behavior of certain mixtures of developer, may be of service.

Too weak a developer makes a flat thin negative.

Too concentrated a developer makes a negative with too much contrast.

Under-developing makes a negative lacking in printing density.

Over-developing makes a thick dense negative requiring a very long time to print.

An under-exposure should be developed with a diluted developer.

An over-exposure should be developed with a concentrated developer well restrained with bromide of potash.

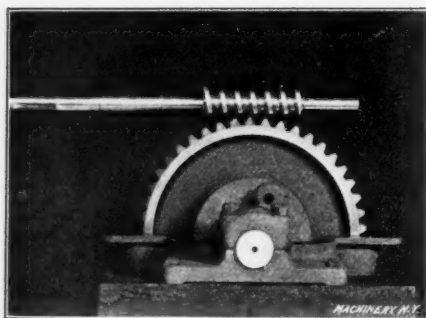


Fig. 7. Photograph of Worm and Gear with Upper Part of Case Removed.

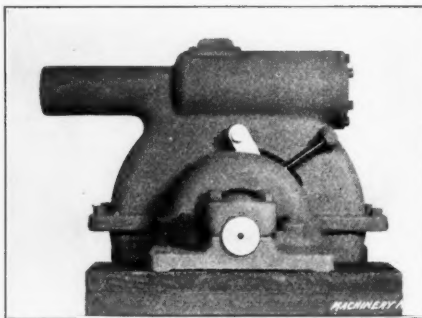


Fig. 8. Exterior of Case to be Photographed on Same Plate as Worm and Gear in Fig. 7.

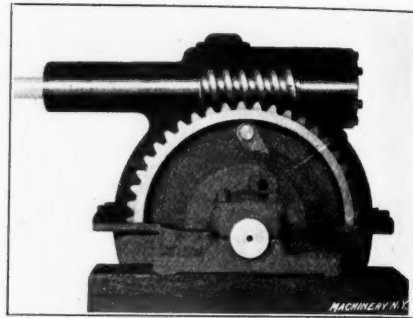


Fig. 9. Result of Exposures of Figs. 7 and 8 on Same Plate.

to the proper density. The positive should have the same treatment.

Reduction does three things: (a.) It reduces or clears the shadows faster than the high lights. Therefore over-exposure is resorted to in order to increase the density of the shadows in proportion to the high lights, so that they shall bear proper relation to each other after reduction. (b.) It thins the density of the negative or positive. Therefore over-developing is resorted to in order to have resulting density after reduction. (c.) It cuts down the hills to the level of the valleys, so that very little if any granular effect is noticeable when the emulsion is magnified.

In reproducing negatives either in the original or a larger size, there is a splendid chance for what may be termed "jockeying." A brilliant negative may be made from a very flat one, and *vice versa*; errors in perspective can be corrected by the method illustrated in Fig. 4; and unequal lighting can be corrected by judicious shading during exposure, etc.

#### X-Ray or Ghost Photographs.

When an illustration is wanted to show clearly some hidden interior part of a machine in relation to and more distinctly than other parts, the usual procedure is to have a wash drawing made in India ink, from which the half-tone is produced. This method is always expensive, and the results are often very unsatisfactory.

In a power-driven machine for cutting paper, the power is transmitted through worm gearing and a positive clutch, all of which is enclosed in an oil-tight case, as shown in Fig. 8. An illustration showing the worm and worm-wheel in mesh was wanted.

The case and its contents were removed from the machine and mounted on a box. The upper part of the case was taken

Developers, like artists' colors, should be mixed with brains. Better choose a moderately slow developer, learn how to use it, and don't let any one persuade you to change it.

The actual printing can, as a rule, be done better by a professional photographer than by an amateur, and as a rule it will be found cheaper to have the prints thus made.

\* \* \*

An ingenious method of regulating the speed of mechanism so as to be absolutely synchronous and to have a known velocity, has been used, which is very simple and worth noting because of the principle. Say that we are given the case of operating a mechanism for autographically recording the pressures of succeeding explosions in a closed receptacle using an apparatus similar to a steam engine indicator, and that it is essential that the speed of the recording apparatus be the same for each test. The method used by Mr. Frederick Grover in his well-known gas explosion tests was to mount a stop watch (that is, one having the second hand in the center) in the mechanism train so as to rotate in a direction opposite to the movement of the second hand and at the same speed. The hand then stood still in space when the mechanism was correctly timed. Any deviation forward or backward showed that the mechanism was running too fast or too slow. A suitable speed-varying device enabled the observer to speed up or slow down the train and thus keep the second hand standing perfectly still. The device is a perfect check on numbers of rotations per minute and the regularity of action.

\* \* \*

According to an English patent specification, celluloid may be made non-inflammable by the addition of chloride of aluminum and nitrate of aluminum.

## DESIGN AND CONSTRUCTION OF METAL- WORKING SHOPS—5.

### SPECIFICATIONS, ESTIMATES AND CONTRACTS IN ENGINEERING PRACTICE.

WILLIAM P. SARGENT.\*

According to Schopenhauer, words and signs simply serve the purpose of fixing conceptions in the mind. The words and signs of engineering are the drawings and specifications, and the contractor will execute his work according to how well these convey to him the conceptions and requirements of the planning engineer. In the specifications, the exact character of the work should be fully and explicitly stated, and the wording should be definite, so as to convey the precise meaning.

Specifications are made up of general clauses covering the general conditions, responsibility of the two parties, etc., and specific clauses covering the details of design and construction. From an analysis of a number of specifications the following points are selected as indicating a consensus of opinion concerning many of the essential features of specifications.

#### General Clauses in Specifications.

1.—A concise and comprehensive statement descriptive of the work to be done in accordance with the drawings and specifications.

*Example.*—The work to be done under this contract comprises the furnishing and erection, on foundations provided by the owners, of two (2) water tube boilers, ready for smoke, steam, and water connections, in strict accordance with these specifications and drawings, Nos. 1 and 2, dated October 10, 1908.

2.—A complete list of the drawings, with the drawing dates, accompanying and forming a part of the specifications.

3.—The drawings and specifications together are to govern the work, and everything called for either on the drawings or in the specifications, or in both, is to be furnished or executed.

4.—Definition of the words "engineer," "owners" and "contractor," as used in the specifications.

5.—The engineer shall explain any obscurity in drawings or specifications, shall decide as to the purpose and intent of drawings and specifications, or of the kind and quality of work or material required thereby, and his decision shall be conclusive.

6.—The contractor shall keep a foreman constantly on the site, the charge of the work being his sole duty.

7.—The engineer shall give lines and levels.

8.—For dimensions governed by conditions already existing the contractor must be governed by measurements taken by himself, scale or figured dimensions notwithstanding, but no deviation shall be made without authorization of the engineer.

9.—The contractor is responsible for the full understanding of the existing condition of the site, and all work or material necessary to change the site to the condition provided for in the specifications, is included in the contract.

10.—Materials and workmanship to be subject to inspection and approval of the engineer who shall have authority to reject any material or work not in conformity with the specifications.

11.—Owners reserve the right to make alterations while work is in progress; additions to, or deductions from, the amount of the contract on account of alterations to be made according to a schedule approved by the engineer.

12.—Owners reserve the right to put other parties at work while the contract is being executed, with the understanding that there shall be no interference with the progress of work under this contract.

13.—Rubbish must be cleared away during the progress of the work at any time the engineer may direct and at the completion of the contract.

14.—All material in the buildings torn down shall be the property of the contractor and any old material may be used in the new work if approved by the engineer.

15.—Contractor must comply with municipal or state ordinances, and shall do all work necessary to so comply whether

called for specifically herein, and shall not make any extra charge on this account.

16.—Contractor must pay for all permits or other municipal charges.

17.—Contractor shall carry builders' insurance to cover the amounts paid from time to time by the owners and assign the policies to the owners.

18.—Contractor shall indemnify and save harmless the owners from all suits or actions of any kind for, or on account of, use of patented articles or rights, and any damages or injuries received or sustained by any party or parties by or from the contractor or his agents or servants in the performance of the work.

Many of the above clauses in the specifications examined differ widely in the intent and are often worded so as to tend to envelop and conceal the meaning rather than to explain it. There is often repetition after repetition of seemingly identical thoughts.

The third clause seems to often cause difficulties, and every engineer or architect has more or less trouble in so wording it that he does not occasionally meet with a contractor who either innocently or wilfully misconstrues the clause in a manner to relieve himself from some work intended.

The fourth, fifth, sixth, and seventh clauses are seldom misunderstood but should be worded very clearly.

The eighth clause is found with a wide variation in intent and wording. Often it is used to throw the responsibility for the architects' or engineers' work onto the contractor. This is palpably unfair. Where would one find, for instance, a designer or draftsman who would send drawings into the shop and expect the machinist to assume the responsibility for the accuracy of the dimensions? Generally a contractor will ignore any clause which makes him responsible for the dimensions, trusting that the specifications will not be strictly held to. Of course there are cases where measurements can not be obtained, except during some period of the work or wrecking, or where existing structures have been used as basing lines, or are not as they seem, and it is perfectly fair to have the contractor verify such dimensions in question, as he is the best fitted to do so. It is better to specifically state such dimensions than to write a general clause that is unfair or that will be tacitly ignored; but it is proper to have the contractor call attention to any real or apparent error, thus affording a chance for investigation and rectification before any loss is entailed.

#### Clauses Found at Times in Specifications and at Times in Contracts.

There are a number of clauses affecting the following points, that are not always found in the specifications but if not, they will be in the contract: time of completion, violation of contract, payments, ownership of work and materials, liquidated damages, bond.

As to the time of completion, it is well that it be stated in the specifications if possible, as the fact that the work should be finished at a definite date appeals to the sporting instinct of the foremen and workmen when they know that it is "up to them." Generally, however, the contractor names the date of completion, and it gets into the contract, but not into the specifications.

Clauses dealing with the monetary part of the transaction seem more properly to belong to the contract. This leaves the specifications entirely an instrument for guidance in accomplishing the material results desired. Very few contractors would care to have the terms of payment or matters of a like nature open to their foremen or workmen as would be the case if such clauses were included in the specifications.

In a paper read by a contractor before an engineering society, some of the shortcomings of specifications were discussed from a contractor's point of view. One statement was: "A contractor should not be held responsible for the stability of a structure, provided the work is constructed as required by the specifications." Another contractor stated that there is positively nothing which raises a bid price like asking a contractor to assume uncertainties.

Specifications are not very interesting reading unless one has some actual work to be performed, but as the general

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figures of cost given previously would not hold good without limitation, the writer will epitomize the specific clauses covering the details of design and construction. Utility, permanency, and low cost are the desiderata governing the same, and buildings erected on these lines should be equal in quality and appearance to the one illustrated in Fig. 30 (see December issue).

**Excavation.**—Depths and widths: per drawing. Specified depth insufficient: notify engineer. Bottoms: level, undisturbed. Material excavated: placed on premises or carted away at engineer's option. Shoring: if necessary; to remain if withdrawing endangers adjacent structures.

**Back-filling.**—As soon as practicable. Puddled and tamped.

**Grading.**—Inside buildings: wet and tamp, per drawings. Immediately around buildings: per drawings.

**Cement, Mortar, Concrete.**—Cement: Portland, to comply with and subject to tests; per specifications recommended by The A. S. C. E.; cement submitted to engineer at least twelve days before using.

**Sand.**—Clean, sharp, and coarse.

**Stone.**—Clean, hard, durable—to pass 2-inch ring in any direction.

**Gravel.**—Clean, hard, free from other matter except sand; proportion of sand such that all voids will be filled.

**Cinders.**—Clean anthracite.

**Lime.**—Thoroughly burned, freshly slaked, clean.

**Cement mortar.**—1 part cement, 2 parts sand.

**Lime mortar.**—1 part lime, 4 parts sand.

**Gaged mortar.**—1 part cement mortar, 1 part lime mortar.

**Concrete.**—1 part cement, 2 parts sand, 5 parts broken stone; 1 part cement, 7 parts gravel; 1 part cement, 5 parts cinders, 2 parts sharp fine gravel.

**Structural Steel.**—Medium steel: 60,000 to 70,000 pounds tensile strength; elastic limit not less than one-half the tensile strength, manganese less than 1.0 per cent. Contractor to furnish all members shown on drawings and all other metal work necessary to the stability of structure; bolts must fit; shop connections riveted; abutted surfaces machined; field connections bolted, except column splices and column connections. Contractor to make his own working drawings, must verify drawings furnished him, and be responsible for accuracy of his drawings in all details; drawings subject to approval of engineer. Painting: one shop coat, two coats on all surfaces inaccessible after erection; finish field work so that all exposed surfaces shall have two coats; paint approved by engineer. Inspection: work and material subject to inspection by inspector appointed and paid by owners; final inspection and acceptance at building.

**Brickwork.**—Brick: straight, hard, sound; face brick selected of uniform color. Every seventh course headers; joints not to exceed  $\frac{1}{2}$  inch; laid to line, shoved joints; masons to set anchors, etc.; openings next to steel work slushed with mortar; walls left clean and neat, using acid solution if directed by engineer.

**Woodwork.**—Kinds and grades specified according to local conditions and practice. Soundness and freedom from structural defects of more importance than appearance.

**Roofing and Sheet-metal Work.**—Slag or gravel roof according to "Barret's Specification" with a guarantee for ten years; flashed up against parapet walls to 12 inches above low point of gutter; counterflashing built into walls, of Taylor's IX Old Style tin; down-spouts with copper intake and copper wire strainer 8 inches high.

**Sky-lights.**—Wired glass at least  $\frac{1}{4}$  inch thick, in copper bars; design approved by engineer.

**Glazing.**—Windows factory ribbed in upper sash. Lower sash and doors D. S. A. quality clear glass.

**Painting.**—All metal work to have two coats, and all woodwork to have three coats when finished; each coat different color.

**Hardware.**—Plain, extra-heavy. Sliding doors on approved hangers and tracks.

**Plumbing.**—According to local ordinances.

#### Estimating on Shop Construction Work.

That the best way to learn to do a thing is by doing it holds true with estimating. The only aid that the writer can offer is of a general nature, as the variable conditions of locality and trade activity affect prices greatly. Unless an engineer has been engaged in contracting, his estimate will generally be lower than a contractor's bid, but his estimates of quantities should not vary materially from those of the contractor.

The following example will show variations in bids from experienced contractors on a factory building, designed by the architects to cost \$160,000. The extreme range of sixteen bids was from \$172,000 to \$230,000. The three lowest bids were within \$1,000; the next three were about \$3,000 higher out within a range of \$1,000. This was close bidding. When

estimating on construction work the engineer should try to put himself in the contractor's place and figure as though responsible for obtaining the contract for the work in competition with others, and at the same time securing a reasonable profit.

"Unit cost," in the following paragraphs, means the basing cost to the contractor, excluding expense items. "Total cost" includes the expense items. "Price" is the amount (including profit) received by the contractor. These prices, obviously, are the costs from the view-point of the owner.

The total cost of material should be estimated as comprising: *a.* The cost F. O. B., shipping, freight, unloading, hauling, storing. *b.* 5 per cent for contingencies. *c.*  $1\frac{1}{2}$  per cent for interest on funds up to the time of payments (partial) by the owner. *d.*  $\frac{1}{5}$  per cent for bond (of contract). *e.*  $\frac{2}{5}$  per cent for builders' insurance. These percentages will vary from those stated for specific instances. To this total cost add a percentage for profit.

The total cost of labor comprises: *a.* Wages of skilled and common labor, or pay-roll; *b.* 5 per cent for superintendence. *c.* 4 per cent for general expenses. *d.* 1 per cent for insurance of workmen and public. *e.* 10 per cent for contingencies. *f.*  $1\frac{1}{2}$  per cent for interest on money. *g.*  $\frac{1}{5}$  per cent for bond. *h.*  $\frac{1}{5}$  per cent for builders' insurance. To this total cost add a percentage for profit.

To make up the total cost of a project to the owners, 5 per cent of the grand summation should be added to cover the cost of engineering.

#### Basing Costs and Prices for Estimating.

The unit prices given below are based either on cost records or on the most reliable authorities in print, and it is believed that estimates incorporating them will be close to fair contract prices if care is taken to add the proper expense and profit percentages that rule in any particular section. The contract prices quoted are not in all cases the lowest, but are selected as being bid by the contractor that would render the best service for the price paid.

#### First Section—Buildings.

**Excavation.**—Cost of labor, in cents per cubic yard in place, based on 15 cents per hour; loosened with pick and thrown on bank: *a.* Loam and gravel, 5 feet deep, 15 cents. *b.* 6 to 10 feet deep, 30 cents. *c.* in loam and clay, 5 feet deep, 20 cents. *d.* 6 to 10 feet, 45 cents. Back-filling: *e.* Loose earth, 5 cents. *f.* Tough earth, 7 cents. Tamping: *g.* 6 cents. Carting: *h.* At rate of 30 cents per mile. In winter, add 50 per cent to *a, b, c, d, e, f, g.* Contract prices: Ohio, 1906-07 (*a*) summer, 25c.; winter, 50c.; Connecticut, 1906 (*c*) 65c.; carting,  $\frac{1}{2}$ -mile haul, 10 cents; excavation, 15 feet deep in clay, and carting (hoisting engine already on ground), \$1.00 per cubic yard; driving tunnel in clay, depth 30 feet, excavation, shoring, and carting, \$3 per cubic yard. See "Gillette's Cost Data" for additional costs on excavation and allied subjects.

**Concrete.**—Cement should be purchased in the winter months to get the lowest price. A fair average cost of cement at the mixer, allowing for waste and lost sacks, is \$1.50. Broken stone, \$1.25. Sand, \$1.00. Gravel, \$0.75 per cubic yard. Cost of materials per cubic yard of concrete in place: 1—2—5 mixture broken stone, \$3.75; 1 to 7 gravel concrete, \$2.25.—Labor: For foundation work, mixing and placing by hand, 60 cents per yard; mixing by machine and placing by hand, 45 cents per yard.—Forms: Labor and material, 40 cents per yard.—Contract prices: Without forms, Ohio, 1907, gravel, \$4 per yard; with forms, \$5 per yard. Connecticut, 1906, broken stone, 1—2—5, without forms, \$6; with forms, \$6.50. These prices are for building foundations. Machine foundations including setting of bolts, pockets, etc.: Ohio, gravel concrete, \$4.75; forms  $7\frac{1}{2}$  cents per square foot additional. Connecticut, broken stone concrete including forms, \$7.—Concrete for ground floors including the setting of sleepers: Ohio, gravel concrete, 18 cents per cubic foot. Connecticut, stone concrete, 22 cents per cubic foot.—Roof slab: Connecticut, cinder concrete, 4 inches thick, 10-foot span, 21 cents per square foot. Ohio, 10-foot span, stone, 25 cents per square foot.—Gallery floors: 250-pound live load, 5-foot spans, cinder concrete, 26 cents per square foot. For 600-pound load, 5-foot span, 35 cents per square foot.—Reinforced concrete tunnels driven in clay 30 feet below surface, 4 x 10 feet inside, \$35 per lineal foot; concrete with forms, \$14 per cubic yard additional. Tunnel: 6 x 8 feet inside with industrial track, turn-table, 12-inch and 15-inch cast-iron pipes in floor, tapped sockets in walls for pipe hangers, \$41 per lineal foot complete. Length about 330 feet, part driven and part open cut.

**Cut Stone.**—For sills, Ohio, 1907, tool planed, \$1.25 per cubic foot. Connecticut, 1906, \$2 per cubic foot; rock faced, \$1.65 per cubic foot. Labor: setting, 25 cents per cubic foot.

**Brickwork.**—Cleaning old brick, \$1 per 1,000. Unloading, 30 cents per 1,000. Cost of brickwork is governed by local prices and wages. Generally one helper is required to each mason. With cement at \$1.50, sand \$1, lime 63 cents per barrel, lime mortar will cost \$1.25 per 1,000 kiln count, gaged mortar will cost \$2.47 per 1,000. One to three cement mortar, \$2.80 per 1,000. One to two cement mortar, \$3.70.—Average price of brick at the yards in 1906: Illinois, \$4.79; Michigan, \$5.70; Ohio, \$5.90; New York, \$6; New England, \$7 per 1,000.—Contract prices: Wall measure (22½ per cubic foot), Ohio, 1906, \$11; 1907, \$11.50. Connecticut, 1906, \$13.30; Illinois, 1908, \$10 per 1,000. Kiln count, or actual brick required will run about 17 per cubic foot of wall.

**Terra-cotta.**—Tile coping for 9-inch wall, 14 cents per lineal foot; corners, 36 cents. For 13-inch wall, 20 cents per foot; corners, 55 cents. Labor setting, 6 cents per foot.

**Windows.**—Plank frames, S. S. glass primed at mill, 15 cents per square foot of wall opening; box frames, D.S.A. glass, primed, 20 cents per square foot; add 1½ cents for hardware; 4 cents for painting two coats; 10 cents for setting

crete, 1 inch cement top, 20 cents; 6 inches concrete, ¼ inch cement binder, 1 inch asphalt, 24 cents.

**Structural Steel.**—Pittsburg, Nov., 1908: Beams and channels, 15 inch and under, \$1.60; over 15 inch, \$1.70; angles 6 inch and under, \$1.60; plates, \$1.60. Following prices should cover the cost to owner of the material erected and painted at any point where freight rate is not more than 15 cents a hundred. Trusses, 1,500 pounds and under, \$65.00 per ton; 3,000 pounds and over, \$60.00 per ton. Single I-beam columns, \$55.00. Plate and angle columns, \$65.00 to \$70.00. Lattice columns, \$72.00 to \$78.00. Plate girders, \$58.00 to \$60.00. Beams, \$50.00 to \$52.00.

**Carpenter Labor.**—This is the most difficult class of construction work as regards estimating, as the "personal equation" enters largely and records of labor cost vary under seemingly like conditions. The following figures should be checked according to local conditions before using, as the quantities run up into big figures. All figures are for board measure, and in estimating allowance should be made for waste if standard lengths cannot be used (multiples of 2 feet), and for the difference between actual dimensions and "strip count" or nominal size. For instance 2x6-inch tongued and grooved material is only 5½ inch face, and 1½-inch thick. Therefore it will require

TABLE XII. PERCENTAGE TABLE OF COSTS OF SHOP BUILDINGS.

	No. 1.		No. 2.		No. 3.		No. 4.		No. 5.		No. 6.	
	Per Cent.	Cents per Square Foot Floor Space.	Per Cent.	Cents per Square Foot Floor Space.	Per Cent.	Cents per Square Foot Floor Space.	Per Cent.	Cents per Square Foot Floor Space.	Per Cent.	Cents per Square Foot Floor Space.	Per Cent.	Cents per Square Foot Floor Space.
Structural Steel.....	100.0	66.8	100.0	89.2	100.0	85.0	100.0	70.8	100.0	71.0	100.0	43.1
Crane Runways.....	7.7	5.1										
Foundations—												
Excavation.....	1.8	1.2					1.3	0.9	0.6	0.4	2.7	1.2
Concrete.....	10.1	6.8					8.4	6.0	7.6	5.4	26.8	11.6
Piling.....												
Concrete and Cement Floors.....	33.6	22.4					12.1	8.6	9.0	6.4		
Mason Work—												
Cut Stone.....	8.3	5.6	2.2	2.0	2.9	2.5	1.9	1.4	0.9	0.7	2.2	0.9
Coping.....	0.6	0.4	20.4	18.0	26.0	22.0	1.0	0.7	17.8	12.7	52.2	21.6
Brickwork.....	27.7	18.5										
Mill Work and Glass.....	12.8	8.5	12.0	10.7	11.7	9.9	9.6	6.8	11.6	8.3	43.9	19.0
Lumber.....	26.5	17.7	20.0	17.8	12.5	10.6	15.0	11.0	11.0	7.9	32.3	14.0
Carpenter Labor.....	7.0	4.7	10.6	10.5	7.8	6.6	9.6	6.8	3.6	2.6	9.1	3.9
Gravel Roof.....	1.9	1.3	2.8	2.5	3.3	2.8	5.0	3.5	5.0	3.7	9.3	4.0
Sky-lights.....	0.7	0.5	19.0	17.0	20.8	17.7	7.4	5.3	6.6	4.7		
Sheet Metal Work.....	7.0	4.7	2.2	2.0	2.9	2.4	4.0	2.8	4.3	3.0	1.8	0.8
Hardware.....	4.4	2.9							0.6	0.4		
Painting.....	8.1	5.40	4.6	4.1	3.7	3.1	3.7	2.6	1.1	0.8	5.4	2.3
Plumbing.....	8.3	5.5									9.4	4.1
Sewers.....							11.3	8.0			5.2	2.2
Wiring and Lighting.....							2.0	1.4	2.8	2.0	4.9	2.1
Heating (does not include power plant apparatus).....							11.0	8.0	22.5	16.0	19.1	8.2
Piping—Air, Water, Oil, Steam.....			6.2	5.5			8.0	5.6			46.2	20.0
Blast-pipe and Blower.....											6.0	2.6
Machine Foundations.....											4.1	1.8
Hammer Foundations.....											9.6	4.1
Shafting Hangers, Belts, Motor.....											13.6	5.9
Furnaces and Foundations.....											24.0	10.4

per square foot. For factory-ribbed glass add 2½ cents per square foot. Metal frames and sash with ribbed wire-glass, \$1.60; with polished plate glass, \$2.35 per square foot.—Metal window shutters, 50 cents per square foot. Window guards, No. 15 galvanized wire, ½ inch diamond mesh, in place, less than 15 square feet to one guard, 20 cents per square foot; 25 to 35 square feet, 17½ cents; 40 to 60 square feet, 15 cents per square foot.

**Doors.**—Wooden sliding doors, in place: 35 cents per square foot; steel rolling doors, 70 cents per square foot.

**Skylights.**—Copper bars, ¼ inch ribbed glass, 60 cents per square foot in place; if wire glass, add 10 cents per square foot.

**Roofing.**—Tar and gravel or tar and slag, \$4.00 per square (100 square feet). Copper strainers with intakes, \$1.50, in place. Down spouts, 5-inch galvanized, 25 cents per lineal foot, in place; 6-inch, 30 cents. Flashing, galvanized No. 24, 14 inch, 7 cents per lineal foot; in place, 14 cents; 20-inch, 13 cents and 20 cents. Counterflashing, material, 10 cents; in place, 25 cents.

**Floors.**—Cost complete, 6 inches gravel concrete, 4x4-inch cedar sleepers, 2-inch centers, tar and sand, 2x6-inch T. & G. Y. P. planking, ¾x4-inch square edged No. 1 Maple top floor, 18 cents per square foot. Contract price, Ohio, 22½ cents per square foot.—Cement floors: 6 inches cinders, 3 inches concrete, 1 inch cement top, 10 cents per square foot. Contract price, Connecticut, 1906, for 5 inches con-

crete, 1 inch cement top, 20 cents; 6 inches concrete, ¼ inch cement binder, 1 inch asphalt, 24 cents. Hence the economy of square edge material, as but ¼ inch to 5/16 inch is required to dress the width. Unloading, from car to wagon or car to pile, 900 feet per hour per man. Purlins: Squaring to length, boring, raising and bolting to trusses, 61 feet per man per hour. Roof sheathing: Raising to roof level, 160 to 200 feet per hour per man. Laying: 55 to 60 feet per hour. Flooring: Gallery; under planking, raising 200 feet per man; laying, 60 feet; maple top flooring, 26 feet per man per hour. Ground floor: planking, 100 to 120 feet per man; maple top floor, 30 feet per man per hour. Nails: For roof sheathing allow 60 cents per 1,000 feet; floor planking, \$1.25; maple top floor, ¾ inch, 55 cents; 1½ inch, 75 cents. Fences: Ordinary board, 60 cents per lineal foot; swinging or sliding wagon gates, \$50.

**Sewers.**—Tile salt glazed pipe F.O.B. site per lineal foot.

	6 in.	8 in.	10 in.	12 in.	15 in.	20 in.	30 in.
Pipe.....	\$0.09	\$0.15	\$0.225	\$0.29	\$0.42	\$0.75	\$2.83
Curves...	0.33	0.60	0.92	1.16	1.58	2.50	
Branches..	0.41	0.68	0.98	1.28	1.88	3.38	
Reducers..	0.40	0.60	0.87	1.13	1.70	3.00	
Lidded Tile		0.20	0.31	0.40	0.52	0.77	

For lidded branches add 33 per cent to cost of standard branches.

Labor.—Excavating, laying and backfilling standard pipe, 125 per cent of cost of material; for lidded pipe, 150 per cent. Electrical tile ducts;  $3\frac{1}{4}$  cents per duct foot or 13 cents per lineal foot of 4-duct conduit. Add 125 per cent for labor.

Percentage tables of cost of buildings are often given in books on estimating, but they are based on the complete cost of the building and some items are given in one table and not in others. This makes such tables almost useless. Table XII. is compiled from the best of these, but is based on the cost of the structural steel which cost does not vary so much as many of the other items. The prices of steel work of different classes previously given includes all expense and profit. Therefore, in making up the total sum for use as a basis for using the table, make allowance only for contingences of 5 to 10 per cent according to the thoroughness with which the quantities are estimated. It should be noted that the cost of skylights is about 15 times as much as gravel roof per square foot. When using the table, the per cent and cost should be increased to the basis of 4 cents per square foot for the roofing when there are no skylights and galleries.

Shop No. 2. Machine shop, 150 x 400 feet, with 37 feet gallery, 40 feet to eaves. Heavy work.

Shop No. 3. Machine shop, 150 x 300 feet, 40 feet to eaves, no gallery; heavy wood floors.

Shop No. 4. Foundry, 31,000 square feet floor space. Sand floor, 30 x 220 feet; main floor, molding sand, 115 x 220 feet; wash room, 31 x 75 feet, cement floor.

Shop No. 5. Foundry, 130,000 square feet. Sand floor, 30 x 450 feet. Brick curtain walls. Office. Wash room, 32 x 120 feet. Yard crane runway included.

Shop No. 6. Forge shop, 13,000 square feet, 25 feet to eaves. Dirt floor. Trolley hoist runway inside of building and over storage yard outside.

#### Second Section—Power Plant Equipment.

**Boilers.**—Horizontal water tube, highest grade; units of 260 or 300 boiler horse-power, F.O.B. site, \$10.00 per horse-power. Foundations, \$1.00 per horse-power. Boiler setting with No. 1 fire-brick in first two passes, \$2.25 per horse-power. Boiler room piping, \$2.50 per horse-power. Breeching, \$0.75. Stokers, \$3.80; setting, \$0.15, but de-

TABLE XIII. POWER PLANT—EFFICIENCY AND COST.

Based on units of 500 Horse-power.

(MACHINERY, February, 1905; Sibley Journal; Author's personal records.)

Type of Engine.		Result.	Cost per Engine H.P., Dollars.																	Total Cost of Plant, 1000 Engine Horse-power.
			Steam, Pounds, per I. H. P.	Coal, Pounds, per I. H. P.	Coal, Pounds, per K. W. Hour.	Proportional Value, Per Cent.	Fuel, Interest, Deprecia- tion per year, Dollars F=\$2.00, I=5%, D=10%.	Labor per H.P. Per Year, Dollars, 9-hour Day.	Boiler H.P. per Engine H.P.	Engine.	Generator, Switch Board, Station Wiring.	Boilers.	Pumps, Condensers, Heaters.	Piping, Foundations.	Stack and Breeching.	Stokers Erected.	Water Softener.	Power House Crane, Coal Hand- ling Apparatus.	Total per Engine H.P.	
Non- Condensing.	{ Simple Slide Valve. }	Average	34.3	4.63	6.9	53.1	42.16	6.50	1.135	8.00	22.00	13.60	2.00	6.00	a*-4.44	3.80	3.20	27.50	90.54	90,000
		Best	31.6	4.61	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	b-2.33	.....	.....	.....	.....	.....
	{ Simple Cor- liss Valve. }	Average	28.3	3.45	5.65	64.5	.....	.....	0.933	12.00	22.00	11.20	2.00	6.50	a-3.69	3.15	2.80	27.50	90.84	90,000
		Best	26.9	3.01	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	b-1.92	.....	.....	.....	.....	.....
	{ Comp. Slide Valve. }	Average	30.7	4.17	6.12	60.2	.....	.....	1.00	11.00	22.00	12.00	2.00	7.00	a-3.91	3.35	2.80	27.50	90.56	90,000
		Best	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	b-2.05	.....	.....	.....	.....	.....
Condensing.	{ Comp. Slide Valve. }	Average	22.7	3.25	4.57	80.5	.....	.....	0.75	11.00	22.00	9.00	4.00	7.50	a-2.93	2.50	0.25	26.00	84.68	85,000
		Best	16.7	2.40	3.60	.....	.....	.....	.....	.....	.....	.....	.....	.....	b-1.54	.....	.....	.....	.....	.....
	{ Turbine..... }	Average	.....	.....	.....	.....	.....	0.67	26.75	.....	8.00	6.25	7.90	a-2.62	2.25	0.25	20.00	74.02	74,000	
		Best	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	b-1.38	.....	.....	.....	.....	.....
	{ Comp. Cor- liss Valve. }	Average	18.2	2.36	3.64	100	23.20	4.80	0.602	16.00	22.00	7.00	4.00	8.00	a-2.35	2.00	0.25	25.50	87.10	87,000
		Best	14.5	1.80	2.7	.....	.....	.....	.....	.....	.....	.....	.....	.....	b-1.24	.....	.....	.....	.....	.....

\* a = brick stack. b = steel stack.

Fuel, labor, interest, depreciation:

Cost per engine H. P. per year, large machine tool shop, \$37.00

Cost per K. W. hour of current consumed, 1.4 cent

running 6000 hours per year.

TABLE XIV. RECENT BIDS ON VARIOUS SIZES OF ENGINES, GENERATORS AND TURBO-GENERATORS, PER HORSE-POWER.

Nominal Engine Capacity.....	300 H. P. 200 K. W.	450 H. P. 300 K. W.	750 H. P. 500 K. W.	Two 750 H. P. 500 K. W.	Founda- tion.	Condenser.	Piping.	Switch Board.	Total per H. P. for 1500 H. P.
Engine.....	\$21.20	18.80	14.45	14.45					
Generator.....	14.78	10.85	7.85	7.85	2.50	4.50	3.39	3.69	\$36.38
Turbo-generator.....			23.30	23.30	1.25	4.50	3.39	3.45	35.89

When using this table for "snap" estimates, add to the total sum, which represents the cost of the buildings alone, the cost of all items necessary to bring the buildings and equipment to an operative basis. The moving of the equipment from the old shops, and the repairing of old machines, should not be forgotten. The hints given in the previous installments of this series will aid in making a complete estimate. It is doubtful if there has ever been an estimate made on the cost of shop improvements that has not been exceeded by the actual costs, as invariably the tendency is towards adding equipment, or making some things better than intended.

#### Description of Shops in Table XII.

Shop No. 1. Machine shop, four story, high-class, 100,000 square feet floor space; steel frame; concrete floors. Live loads: second floor, 250 pounds per square foot; third and fourth floors, 200 pounds each. Roof: 2 x 6-inch plank, slag and tar, load 50 pounds per square foot. Ground floor: concrete with sleepers and 1½-inch maple top floor; upper floors 1½-inch maple. Windows, 65 per cent of wall surface. Two stair towers; two elevator shafts; one closet tower outside of main floor space.

duct \$0.60 for grates and fronts not used. Stacks: Steel stacks, gaged, one stack to each unit, \$1.80 per horse-power. Self-supporting, one stack to 2 units, \$2.50 per horse-power erected. Radial brick stacks, one for complete plant, 150 feet high with fire-brick core 50 feet high, \$3.90 per horse-power. Balanced draft, \$5.00 per horse-power (reduces the cost of the stack 50 per cent). Feed water heaters, \$0.50 per horse-power. Water softening apparatus for 1,000 horse-power, \$2.80 per horse-power (non-condensing plants or where jet condensers are used). Vertical water tube boilers, with stack on foundations, ready for steam and water connections, \$13.00 per horse-power. Engine room equipment is given in Table XIII. Coal-handling apparatus: Track hopper and bucket conveyor to pockets, capacity 20 tons per hour, erected, \$7,650.00. Coal pockets, roofed, with chutes and measuring gages to stokers, capacity 300 tons, erected, \$6,050.

#### Third Section—Miscellaneous.

**Conveyors.**—Belt, 18-inch erected on steel supports, \$11.50 per lineal foot of conveyor; 24-inch, \$15.00 per lineal foot. If on wooden supports, \$1.00 less for each size. Vertical bucket conveyors, \$20.00 per foot of lift. Track hoppers, unloading from drop bottom cars, \$250.00 erected.

**Locomotive Cranes.**—15 ton capacity and with power and speed sufficient for use in switching, with cab enclosed, and

double drum arranged for handling two line grab bucket, complete with ballast ready for use, \$6,500.00.

**Grab buckets.**—Single line, 25 cubic feet capacity, \$1,100.00; 45 cubic feet, \$1,300.00. Two line buckets, \$350 and \$500.

**Cranes.**—Traveling, erected, 15 ton, 50 feet span, \$3,700, with auxiliary hoist, \$550 additional; 10 ton, 50 feet span, \$3,500; 5 ton, 50 feet span, \$3,000; 25 feet span, \$2,000; 3 ton, 25 feet span, \$1,500; 3 ton trolley hoist, \$1,250.

**Elevators.**—Belt driven freight elevators, erected, 3 ton, 40 feet per minute, \$900; direct driven electric, 3 ton, 75 feet per minute, \$2,500; 30 feet per minute, \$1,700; hydraulic, 25 feet lift, 75 feet per minute, \$2,000; 50 feet per minute, \$1,200.

#### Contracting and Purchasing.

In every case the engineer must ask for bids. The various building contractors should be considered on the following points: Commercial integrity and general reputation; capabilities for handling contract in connection with other contracts on hand; organization and speed of execution of large contracts of the class of construction required; quality of workmanship; freedom from labor troubles. It will be found that the number of desirable bidders, when critically examined, is not large in any particular locality, still a list can be made, not neglecting those who can handle small contracts well, and rated according to the size of contract that each can handle.

General contractors will generally use the lowest bids from sub-contractors in making up their bid. The engineer should require that a list of sub-bidders should be furnished and approved by him, as often the best contractors on parts of the work will not put in bids to the general contractor, but will bid direct. It is well to encourage the smaller bidders in this practice, as the engineer can study their efficiency and reliability. The advantage to the engineer lies in obtaining accurate data of cost of various parts of the work and being able to guard against combinations and unbalanced bids.

#### Classes of Contracts.

Competitive bidding and a lump sum contract (at the present time) is probably the most satisfactory to the owner, and will enable the total cost to be known in advance of the commencement of work. The cost-plus-a-percentage-plan is greatly in the contractor's favor, as the greater the cost the greater the contractor's profit and there is no incentive to rush the work. The cost-plus-a-fixed-sum-plan is the best if operations must be commenced before thorough plans and specifications can be prepared.

It eliminates the element of risk to the contractor, but throws a great deal of work and worry onto the owners that would be assumed by the contractor under a lump sum contract. As to speed, that depends entirely on the organization of the contractor's forces and his desire to make a reputation for rapid execution of contracts. His pecuniary interest is no greater if the work progresses rapidly than if it lags. With a lump sum, the rapidity of construction almost always tends to larger profit to the contractor without any addition to the amount that the owner has reconciled himself to pay.

#### Form of Contract.

Without going into the legal points of engineering contracts, the more important particulars are: Definiteness of statement regarding the work included in the contract and that the drawings and specifications are a part of the contract and equally binding with the clauses of the contract proper; the terms of partial and complete payments and the conditions of acceptance of the work prior to such payments; provision for completing the work in the event of the contractor failing in the performance of the work or otherwise violating the terms of the contract; liquidated damages for non-completion of contract in the prescribed time; provision for the extension of the time in which the contract is to be completed according to changes and causes beyond the contractor's control. The "uniform contract" recommended by the American Institute of Architects is in the main satisfactory to both owner and contractor.

Regarding mechanics' and other liens, the engineer should investigate the State laws and protect his principals from a double payment in the event of the contractor failing and leaving material and work unpaid for.

#### Purchasing Equipment.

The conditions governing the purchasing of equipment are of a different nature from those pertaining to the building trades, but where specifications are drawn by the engineer for equipment, the same care should be exercised in stating definitely what is wanted.

Generally the only specifications that need be drawn by the engineer are: that the apparatus shall perform a given amount of work in a given time; that this amount shall be guaranteed under actual working conditions; that in the installation the maker shall instruct in the operation; that the apparatus shall be erected and operated and tested to fulfil the guarantee; that repairs during a year caused by defects and workmanship shall be charged to the maker; that the efficiency or cost of operation shall be stated as a part of the guarantee.

\* \* \*

#### GUARD FOR EMERY WHEELS.

The half-tone below illustrates a simple but effective guard for emery wheels, brought out by the Vereinigten Schmirgel- und Maschinenfabriken, Hanover-Hainholz, Germany, and illustrated in the *Zeitschrift für Werkzeugmaschinen und Werkzeuge*, Nov. 25, 1908.

A particular feature of this guard, outside of its adjustability to different sizes of emery wheels, is also the elastic construction which provides for absolute safety in case the wheel should burst. In case of ordinary cast iron guards, it often happens that the emery wheel, bursting when running

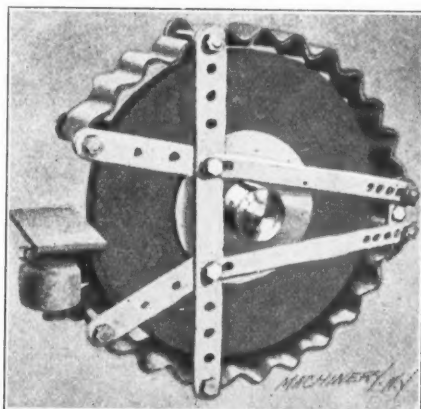
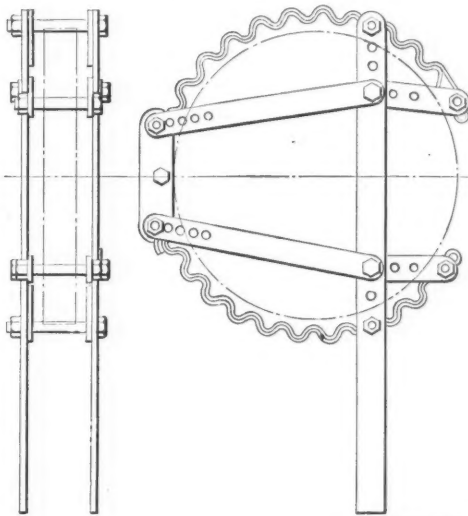


Fig. 1. Elastic Emery Wheel Guard which is able to withstand Severe Shocks.

at high speed, breaks the guard also and scatters pieces of the guard around the room. The severity of injuries is, of course, lessened by the resistance of the guard, but damage is not entirely eliminated. In the guard shown in the illustration herewith, however, the parts of the wheels strike against a corrugated band, composed of several laminations



Machinery, N.Y.

Fig. 2. Elevations of the Corrugated Guard.

of sheet steel. On account of the corrugated construction, the guard possesses an elasticity which aids in preventing breakage of the steel laminations in case of accident. Experiments have been undertaken by the manufacturers to ascertain the ability of the guard to withstand the bursting of wheels, and these experiments have been highly successful.

\* \* \*

The largest concrete arch bridge in the world was recently completed in Switzerland. It comprises a central arch of 259½ feet and six 33-foot arches in the approaches.

### BALLENTINE HARDNESS TESTING DEVICE.

In the September issue of *MACHINERY*, the Brinell method of testing the hardness of metals was described in an extended article. The principle involved in testing the hardness of metals by this method is based on the fact that the

hardness of metals may be compared by recording the resistance of the metal to indentation. If indentations are made in various substances by the same force transmitted through the same medium, the relative hardness of different materials can be measured by determining the dimensions of the indentations. This is, in principle, the system employed by the Brinell apparatus.

The fact should not be overlooked, however, that the measuring of the dimensions of such indentation is more or less difficult to accomplish accurately, and the method requires special instruments for obtaining the indentation, and for measuring the amount of depression in the metal tested. In order to overcome this difficulty, a means known as the Ballentine method and apparatus for quickly and accurately determining the resistance to indentation of a material has been devised and constructed.

The method employed by Mr. Ballentine consists in allowing a hammer of specified weight to fall through a specified height on an anvil to which is connected a pin which rests on the specimen to be tested. An indentation in the material is obtained, but the resistance encountered, instead of the dimensions of the indentation, is measured. This resistance is measured by the blow of the hammer being transmitted to the test pin through a soft metal recording disk located at the lower end of the hammer. This disk affords a constant resistance to deformation, and will be indented to a depth varying in proportion to the resistance the pin encounters in indenting the material tested. The recording disk is usually made from lead.

The accompanying half-tone and line engraving show the general appearance and a sectional view of the apparatus, which consists of a guide tube encasing the drop hammer which at the lower end is provided with a small anvil to which is clamped a lead disk.

At the upper end the hammer is held at the top of the tube by a spring latch. At the lower end of the tube a test pin holder is located, in which are inserted the test pins for testing the various materials. The upper end of the test pin holder is provided with an anvil of the same diameter as the one on the lower end of the hammer. A small spirit

level is inserted in the top of the tube for leveling the apparatus, and two small slots are cut in the guide tube for inserting and removing the recording disks. The apparatus can be used to test all materials which can be ordinarily machined by steel cutting tools, but cannot be used for hardened steel and similar materials which are too hard to be indented in this manner. Two test pins are provided, one for soft materials such as lead and babbitt metals, and another for harder materials such as iron and steel. The pin for hard material is very short and small in diameter while the pin for soft material is longer and larger in diameter.

The testing can be made either on small test specimens or directly on large parts in process of manufacture, the great advantage of this hardness tester being that it is entirely

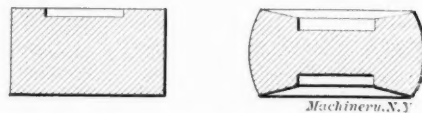


Fig. 3. Lead Recording Disk, Before and After Test.

self-contained and well adapted for either laboratory or general shop use. To make a test it is only necessary to smooth off a surface on the specimen to be tested, and clamp it firmly to some rigid body.

In Fig. 3 is shown a lead recording disk before and after the test. These disks are made within 0.0015 inch of nominal size from a material as nearly of uniform density and hardness as obtainable. The disk is measured with a micrometer before being placed on the drop hammer. When the test has been made, the thickness of the metal between the two recording anvils is again measured, and the difference between the two dimensions will indicate the resistance to indentation or the hardness of the material tested. If, for instance, the disk measured 0.300 before the test, and 0.156 after the test, the difference, 0.144 inch, indicates the hardness of the material, and this hardness would be known as No. 144. The device is manufactured by Tinius Olsen & Co., 500 N. 12th St., Philadelphia, Pa.

\* \* \*

The following ingenious invention of a combustion motor for automobiles is described in *Svensk Motortidning*. A promising young inventor was grappling with the problem of bringing out an economical 20-horse-power combustion engine, and in doing so he studied a great many trade catalogues of accessories for engines of this kind. His investigations led him to the conclusion that by judicious selection of integral parts of the machine he would be able to bring out an engine which would come very close to becoming a perpetual motion machine. He obtained guarantees from various firms manufacturing the smaller details as to the amount each would save in fuel, and constructed an engine provided with a special carbureter, saving 30 per cent, and provided with bearings of special metal saving 12 per cent of the fuel. A governing apparatus saving 18 per cent was applied to the engine, and besides a muffler saving 10 per cent, an automatic lubrication system saving 15 per cent, a patented valve arrangement saving 11 per cent, and finally a system of ignition guaranteed to save 5 per cent; adding up his percentages of saving the inventor found that he had saved exactly 101 per cent of the fuel required. Allowing the superfluous one per cent for frictional and undetermined losses, he thus found that by the combination of the above inventions he had obtained an engine which would work without any fuel whatever, and he naturally made application for a patent on the combination of these wonderful apparatus. The principle is so simple that it is almost irritating that one did not think of it oneself. The invention reminds us of the planer salesman who, among other things claimed for his planer, said that while it took a great deal of power to start it, when once started, it ran so easily that it actually at times would drive the engine.

\* \* \*

An exposition of the means and appliances for the safeguarding against accidents from machinery and implements is being held under the auspices of the Industri Foreningen, Copenhagen, Denmark, and will be continued during January and February.

Figs. 1 and 2. General View and Section of Ballentine's Hardness Testing Device.

## HOW MANY GASHES SHOULD A HOB HAVE?

RALPH E. FLANDERS \*

The question of how many gashes to cut in a worm hob, particularly if the hob is multiple-threaded, has always been a puzzling one for most mechanics, including in that number the writer of this article. Until recently he had supposed that the only requirement that had to be met in this matter was that discovered by Mr. Beale, of the Brown & Sharpe Mfg. Co., at the time the writer was employed by that firm. This requirement is that the number of gashes must have no common factor with the number of threads in the worm. That

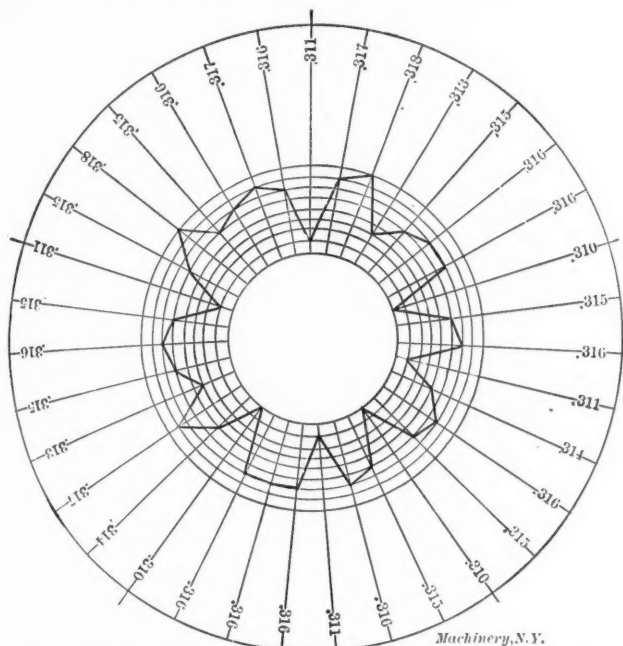


Fig. 1. Thick and Thin Teeth, produced by Incomplete Generating Action on the Part of the Hob.

is to say, if the worm is quadruple threaded, the number of gashes should be 9 or 7 rather than 8. If the work is sextuple threaded, the number of gashes should be 7 or 11 rather than 8, 9 or 10. This is one requirement, but there seem to be other factors that enter into the decision as well. These were brought to the attention of the writer by Mr. N. B. Chace, superintendent of the Cincinnati Shaper Co., in his attempt to get a hob that would cut smooth, regular teeth for the worm-wheel of the spindle drive in a machine he was building.

The worm-wheel of this drive had 35 teeth. The worm had 7 threads and a lead of 5 inches. The number of flutes or gashes in the hob was 9. These gashes were milled spirally so that they were at right angles to the thread. The hob was made by a well-known firm which makes a specialty of such work; it was proved by subsequent tests to be accurately and finely made, and altogether a very creditable piece of work. Do what he could, however, Mr. Chace was unable to hob worm-wheels that would be satisfactory. When tried in place in the machine and run with the worm, each one appeared to have five low spots, something as if the pitch line were a pentagon instead of a circle. The wheels were taken out and the thickness of the teeth in the center of the throat at the pitch line measured as accurately as possible. The results of one of these tests, made at the time of the writer's visit, is shown in Fig. 1, where it will be seen that there is a regular recurrence of thin teeth in each fifth of the circumference of the wheel with less marked series of fine intermediate thin teeth. The diagram in the center of the figure shows graphically (by the exaggerated radial distance from the center), the variation in the measurements obtained. The first thought would naturally be that the hob had warped out of true in hardening, in which case the ratio between the worm and the wheel of 5 to 1 would give the error indicated; but careful measurements failed to detect any error of this kind, either in the periphery of the hob or on the sides of the cutting edges.

\* Associate Editor of MACHINERY.

## The Imperfect Generating Action of the Hob.

To find what was really the trouble with the hob (or rather, with the work of the hob, for the hob was found to be all right), it will be necessary to study its action in cutting a worm-wheel. The diagram in Fig. 2 will serve to illustrate some of the important points connected with this action. In the upper part of the diagram at the right is shown an end view of a single threaded hob having six gashes. To the left of this is shown the pitch cylinder of the hob with a helix traced upon it, representing the center of the thread. Lines parallel with the axis of the work are drawn on this pitch cylinder, representing the intersection of the faces of the teeth with the cylinder. The intersections of the helix with these lines at *a, b, c, d—q*, represent the positions on the pitch cylinder of the center of each of the teeth of the hob. Below this representation of the pitch cylinder is shown a development of its circumference through an axial length equal to the linear pitch of the worm, represented in this case by the distance *ci*. On this development, the tooth helix between *c* and *i* becomes a straight line, as shown, and the center of the tooth faces *c, d, e, f, g, h* and *i* are developed, as before,

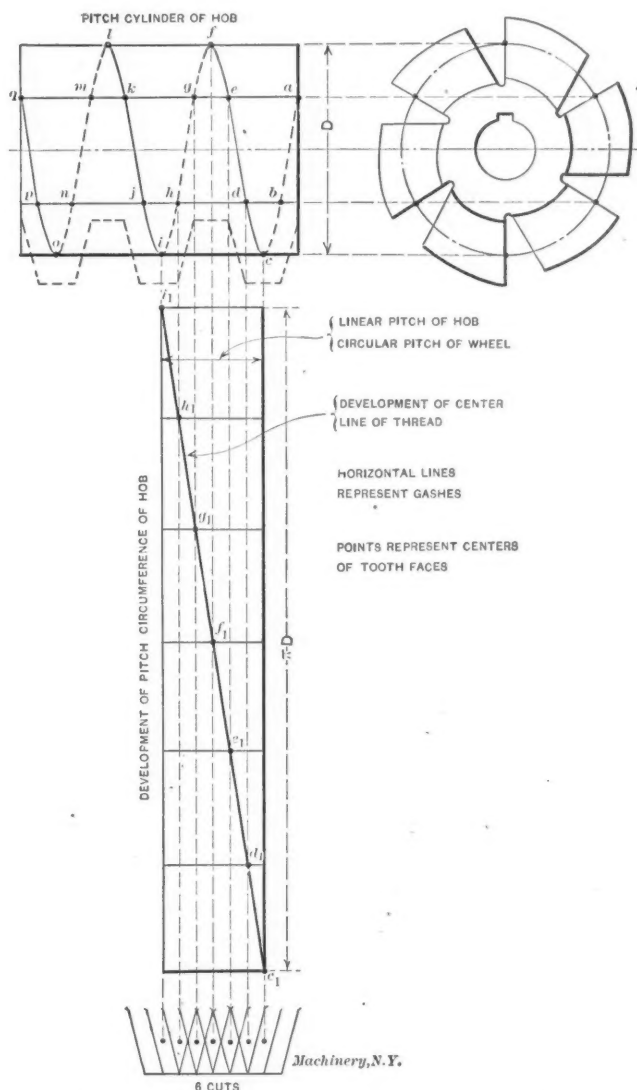


Fig. 2. Finding the Number of Cuts per Linear Pitch.

by the intersection of this tooth line with equally spaced horizontal lines representing the six gashes in the circumference. Below this development of the circumference of the hob is shown a series of outlines of the cutting edges of the hob, each one of which has its center directly below the corresponding center *c, d*, etc., in the development. These outlines evidently represent the successive positions of the teeth of the hob as they pass the plane of the throat of the worm-wheel in hobbing its teeth. There are seven of these positions, but as one of them belongs to the next section of the hob, from *i* to *a*, the diagram shows six positions of the hob teeth in the linear pitch of the hob.

This means, of course, that the hob does not accurately generate a tooth of the wheel, since it acts on it only in the six successive positions shown, instead of continuously throughout the whole distance of the circular pitch. In order to get smooth accurate teeth, the number of cuts in the linear pitch must be made as many as possible; the more there are, the more nearly perfect would the generating action be; the less there are, the rougher will be the tooth. Now, as will be shown later, there is but *one* cut per linear pitch in the example mentioned in the second paragraph of this article. Under these circumstances, the teeth of the worm, instead of being smoothly generated to a curve, are

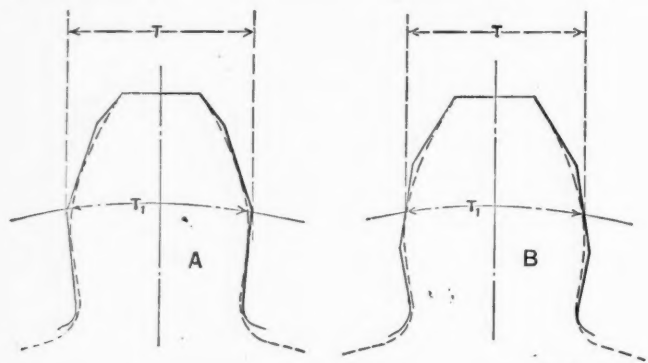


Fig. 3. Example of Thick and Thin Teeth from Incomplete Generation.

only slabbed out by a series of flat cuts, as indicated in Fig. 3. The reason for the five thin teeth in the circumference is now evident. At every fifth of a revolution those teeth of the hob which formed the outline near the pitch line of the gear gave it a shape similar to that shown at the right of the engraving. In the thick teeth, the conditions shown at the left are found, where the outline of the tooth at the pitch line is formed by cuts so placed as to make corners at this point instead of flats as at the right. This means that the teeth measured on the pitch line are thick at one point and thin at the other, giving high spots, as found by running the wheel with the worm, and as indicated also by the measurement shown in Fig. 1. The reason for the intermediate thin spots between the even fifths is not clear from the preceding explanation, but they are doubtless due to the particular arrangement of the flats on the tooth outline which happens in this particular wheel.

#### Diagrams for Finding the Number of Cuts per Linear Pitch.

It is evidently a simple matter to draw diagrams for any case showing the development of one linear pitch on the pitch surface of the hob, as in Fig. 2, and find out from that diagram how many cuts the hob gives in that distance. In Fig. 4 eight such diagrams are shown, for eight different cases. The first case is a single threaded hob, having five gashes. This diagram, which is similar to the one in Fig. 2, shows that there are five cuts to the linear pitch. In the second diagram a hob of the same diameter and the same linear pitch having also five gashes, but quintuple instead of single threaded, gives but one cut to the linear pitch. This is evidently a very bad condition and one to be avoided, if possible, and it is evidently brought about from the fact that the number of gashes is the same as the number of threads. In the third and fourth cases the number of gashes has been increased to six, with a single thread in one case and a quintuple thread in the other. In each case there are six cuts to the linear pitch. The fifth and sixth cases are the same as the first and second, except that the lines representing the gashes have been drawn at right angles to the lines representing the tooth helices as would be necessary for hobs which are gashed helically in a direction normal to the tooth helices. These cases will be seen to correspond to Nos. 1 and 2 except that the number of cuts has been increased in proportion to the cosine of the gashing angle, so that we have 5 + cuts for case five, and 1 + cuts for case six. In cases seven and eight are shown the same conditions as in cases three and four, except that the hob is gashed helically. In this case, also, the number of cuts is increased in inverse proportion to the cosine of the gashing angle, giving 6 + and 7

+ cuts respectively for the two cases, the hobs having six gashes each.

In Fig. 5 are shown four more cases, considerably more complicated than those in Fig. 4. Here are four hobs, all of the same linear pitch and pitch diameter, and all octuple threaded, with threads of the same lead and helix angle, the only difference in the four being in the number of gashes and the method of cutting them. In Cases IX and XI there are eleven gashes, and in cases X and XII there are twelve. Cases IX and X are gashed parallel with the axis. This, of course, would be utterly impracticable in any hob having threading angles as great as those shown here, so the example is not a practical one, being used only for the sake of illustrating a principle. Cases XI and XII which are gashed helically and normally at right angles to the threads, represent what would be the practical construction of these hobs. Projecting the intersections of the thread lines with the gash lines, down to the bottom of each diagram, we get for Case IX, eleven cuts linear pitch; for Case X, three cuts to a linear pitch; for Case XI, 38 + cuts; and for Case XII 11 + cuts.

#### The Effect of the Number of Teeth in the Wheel.

But there is still another factor entering into this problem—the number of teeth in the wheel. This is the factor which gave so much trouble to the superintendent in the job mentioned at the beginning of the article. Take, for instance, Case IV in Fig. 4. Suppose that the quintuple

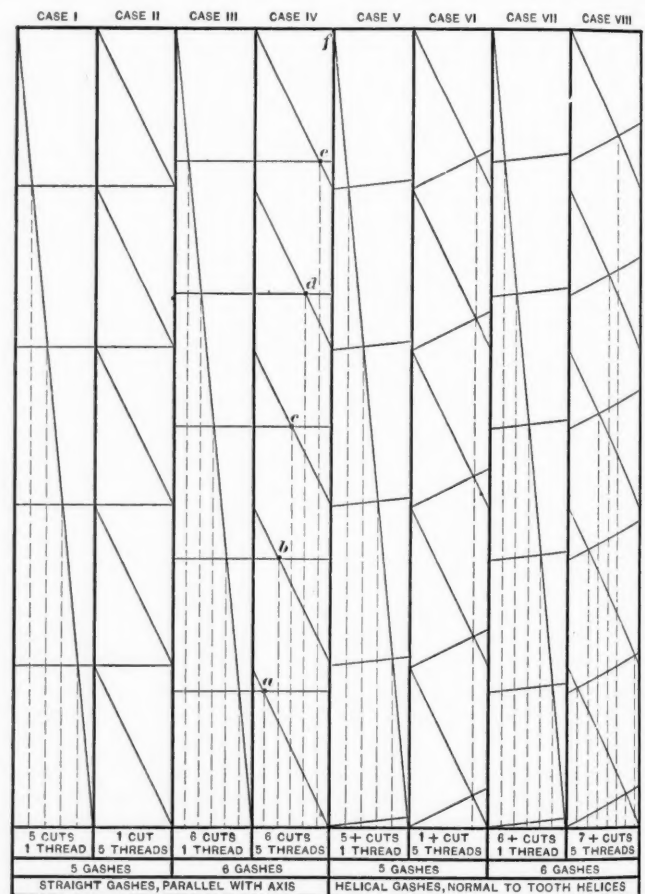


Fig. 4. Diagram for Finding the Number of Cuts per Linear Pitch.

threaded, six-gashed hob represented by that diagram, were cutting a 25-tooth wheel, it would not give the six cuts indicated by the diagram. The reason for this will appear by comparing Case IV with Case III. In Case III, where the hob is single threaded, all of the cuts represented by the points of the intersections of the thread and gash lines, are along the same thread. In Case IV, however, each of the five thread lines in the diagram has but one intersection. That means that if the number of teeth in the gear, as in the supposed example, is a multiple of the number of threads in the worm or hob, each of those threads will come back into the same tooth spaces in the wheel at each revolution of the latter, so that for each tooth space there is but one cutting

position of the hob tooth—that represented, for instance, by point *a* for one of the tooth spaces, point *b* for the next, *c* for the next, and so on. If, on the other hand, there were 26 teeth in the wheel, the first time it went around, point *a* would cut in a certain tooth space; the second time around point *b* would come in the same space, and the third time around point *c* would follow, so that each tooth space would get the benefit of each one of the six cuts, the same as in the single thread worm for case three. It is thus seen that, besides the other points mentioned, the number of teeth in the wheel has an effect on the number of cuts of the worm per linear pitch. In the practical case mentioned in the opening paragraph, there was a 35-tooth worm-wheel and a 7-threaded worm, giving the worst conditions possible.

#### A General Formula for Determining the Number of Cuts.

From the preceding description it will be seen that there are three points to be taken into consideration in determining the number of cuts per linear pitch (and the consequent generating efficiency of the worm) from the number of gashes

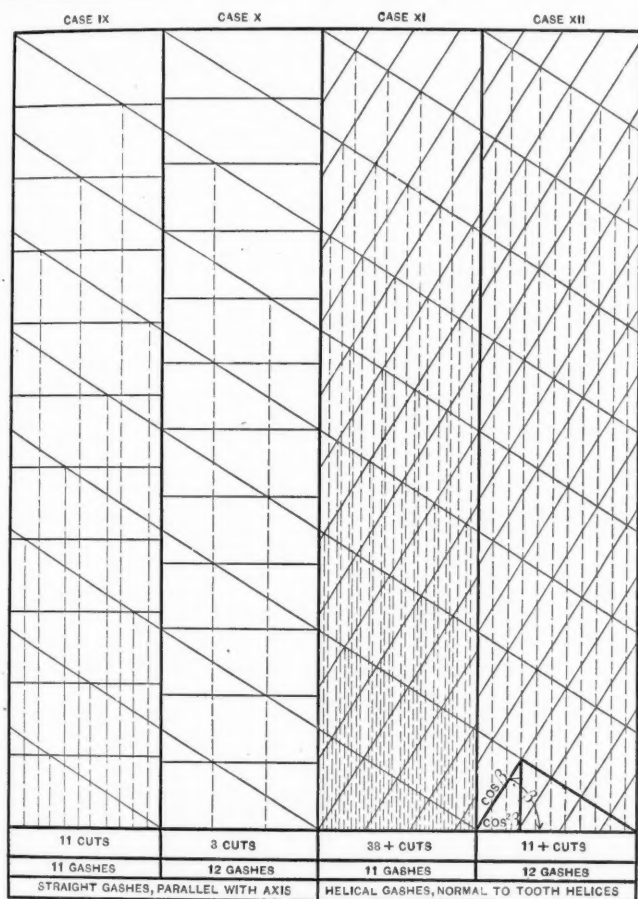


Fig. 5. Diagram for Finding the Number of Cuts per Linear Pitch.

in the hob. These factors are: First, the relation of the number of threads of the hob to the number of gashes. Second, the angle of the gashing. Third, the relation of the number of threads of the hob to the number of teeth in the wheel to be cut. [It might be considered that there is a fourth factor, that of the absolute number of teeth in the wheel, since the trouble that comes from a small number of cuts per linear pitch is exaggerated in the case of a wheel having very few teeth. This is not a matter of calculation, however, and would not enter into the calculations anyway, since for any given case for which a hob is being designed, the number of teeth in the wheel is determined approximately at least.]

Now, instead of drawing diagrams such as shown in Figs. 2, 4 and 5, it would be better if a simple mathematical expression could be obtained which would give the number of cuts per linear pitch directly. This can easily be done. The effect of the number of gashes with relation to the number of threads is as follows: *The number of cuts per inch varies inversely with the greatest common divisor of the number of threads and the number of gashes in the hob.* The influence of the number of teeth in the wheel is a similar one and may be expressed as follows: *The number of cuts per linear pitch*

*varies inversely with the greatest common divisor of the number of threads in the worm and the number of teeth in the wheel.* The effect of the angle of the gashing may be expressed as follows: *The number of cuts per linear pitch varies inversely with the square of the cosine of the gashing angle, measured from a line parallel with the axis of the hob.* These statements are combined in the following formula:

$$X = \frac{G}{D \times D' \times \cos^2 \beta}$$

in which

$G$  = number of gashes,

$\beta$  = angle of gashing with axis,

$D$  = G. C. D. of number of threads and number of gashes in hob,

$D'$  = G. C. D. of number of threads in hob and number of teeth in wheel,

$X$  = number of cuts per linear pitch.

G. C. D., of course, stands for "greatest common divisor."

It is easier to see the relationships expressed above, from the foregoing diagrams and description, than it is to explain them. These relationships, though quite simple, are rather elusive. Perhaps, however, the effect of the angle will be understood from the figuring of the triangle at the base of the diagram for Case XII. Note that the formula is true only for the usual cases in which the gashing is either helical and normal to the threading, or straight and parallel to the axis. In the latter case,  $\cos^2 \beta = 1$ , since  $\beta = 0$  deg., and the effect of the angle disappears.

Applying the formula to the practical example given in the second paragraph, we have the following values:

$G = 9$ ,

$\beta = 20$  deg. (assumed, as the angle was not given),

$D = 1$  = G. C. D. of 9 (number of gashes) and 7 (number of threads),

$D' = 7$  = G. C. D. of 7 (number of threads) and 35 (number of teeth in wheel).

Solving for the number of cuts per inch we have:

$$X = \frac{9}{1 \times 7 \times 0.9397^2} = \frac{9}{6.181} = 1.45.$$

If the number of teeth in the wheel had been 36 instead of 35 the number of cuts would have been

$$X = \frac{9}{1 \times 1 \times 0.9397^2} = \frac{9}{0.883} = 10.19$$

which, it will be seen, would immeasurably improve conditions, giving a fine, smooth outline for this number of teeth in the wheel. In the actual wheel, as cut by the hob, the slab-sided effect shown in Fig. 3 was very noticeable, there being about three cuts to each face of the tooth.

#### Hobbing Methods which give a Complete Generating Action.

It should be noted that while this faulty generating is liable to occur with hobbing by the usual method of sinking the cutter in to depth in a blank, the same difficulty does not occur in the fly-tool process or in a machine using a taper hob fed axially past the work, as described for the Atlas, Eberhardt Bros., Wallwork and Reinecker machines referred to in the article on "Gear-Cutting Machinery" in the June, 1908, issue of MACHINERY. In the case of these machines, working with either taper hobs or fly-cutters, the number of cuts per pitch is, at the least calculation, the number of revolutions per linear pitch of advance of the cutter spindle; it thus runs up into the thousands, where the diagrams shown in Figs. 2, 4 and 5 give only from 1 to 38.

So far as the writer is able to see at present, this treatment of the hob question, suggested by the experiences of the superintendent of the western machine shop, takes care of all the factors which enter into a determination of the number of gashes to use in a hob, so far as this affects the accuracy of the generating action. Expressed briefly, the conclusions are:

Avoid having a common factor between the number of threads and the number of gashes in the hob.

\* Avoid having a common factor between the number of threads in the hob, and the number of teeth in the wheel.

\* Owing to special conditions, Mr. Chace was unable to meet this requirement.

## HELICAL SPRINGS.

HENRY L. HANSON.\*

The four tables accompanying this article (see Data Sheet Supplement) give the greatest allowable pressure or load in pounds, and the corresponding compression or deflection in inches per coil of helical springs of various sizes. The same values for helical springs of square steel with like diameters, may be found by multiplying the greatest allowable loads for round stock by 1.2 and the deflections by 0.59.

It is proper to state in the beginning that helical springs are not spiral springs, as they are so often miscalled by the majority of machinists, and even by mechanical engineers. A spiral spring is one in which the coils lie in the same plane, being wound around a center and continually receding from it the same as a watch spring. A helical spring is one that is wound around an arbor, advancing like the thread of a screw. A volute spring, in a sense, might be said to be a combination of the two, being shaped like a cone.

As will be seen from the Tables, the values given therein are for springs made of a good quality spring steel, varying in fiber strength from 80,000 to 150,000 pounds per square inch of section. The maximum fiber strength of the larger sizes of common spring wire or rods has been shown by repeated tests to be somewhat less than the figures given in the tables, but for the smaller sizes of wire the fiber strength obtained by test compares very favorably with the figures given. The greater strength of the small size of spring wire, no doubt, is due to the fact that it is drawn down from large stock, each draft increasing its strength because of the refining effect of the dies on the surface of the metal. In the large sizes, the proportionate increase of strength due to the refined metal is not so much. In fact, large sizes of helical springs often are made from rods or bars taken directly from the rolling mill.

The tables are based on the J. W. Cloud adaptation of spring formulas given in "Kent's Mechanical Engineer's Pocketbook" on page 351 where  $P = \frac{S \pi d^3}{16R}$ ; and  $f = \frac{32 P R^2 l}{G \pi d^4}$

in which

- $P$  = load of spring,
- $S$  = maximum shearing fiber stresses in bar,
- $d$  = diameter of wire or rod,
- $R$  = radius of spring, measured to center of wire,
- $l$  = length of rod before coiling,
- $G$  = modulus of shearing elasticity,
- $f$  = deflection of spring under load.

The second formula becomes on substituting for  $P$  its value in terms of  $S$ :  $f = \frac{2 R S l}{d G}$ ; and neglecting the difference between the circumference of a circle and one coil of a helix, it can be written:  $f = \frac{64 P R^3}{d^4 G}$ . A large number of tests were re-

cently made with springs of various sizes of wire and diameters of coil to determine the accuracy of these formulas and of these tables compiled. On the whole the formulas and tables deriyed were found to be very close to the average results, especially on springs made from small wire.

The load for a spring, as given in the tables, is the greatest allowable pressure; therefore, a factor of safety should be used for all spring installation, depending on the nature of the service. A spring being made of elastic material and of such shape as will permit of great relative deflection, will not be affected by sudden shocks or blows to the same extent as a rigid body. Consequently, a factor of safety very much less than for the rigid members of a machine body may be employed. The factor of safety varies, of course, according to the service, and the following are considered good practice. For no vibration, use a factor 1.5; for moderate vibration, 2; and for incessant vibration, 3. To illustrate the use of the tables, a few examples will be given.

Example 1: What is the greatest allowable load for a spring made of  $\frac{1}{4}$  inch round wire,  $1\frac{1}{4}$  inch outside diameter? The mean diameter of the spring, which corresponds to the

pitch diameter of a gear, is the outside diameter minus the diameter of the wire, and in this case is  $1\frac{1}{4}$  inch —  $\frac{1}{4}$  inch =  $1\frac{1}{2}$  inch. From Table II, we find that the greatest allowable pressure or load is 513 pounds, and that the deflection is 0.338 inch per coil.

Example 2: Assuming that the foregoing spring has 15 coils, close wound, how much is the extension under a load of 513 pounds? In calculating the deflection, we consider the two end coils as inoperative; this then leaves 13 working coils, and the entire deflection of the spring would be  $13 \times 0.338$  inch = 4.394 inch.

Example 3: A spring made of  $\frac{1}{2}$ -inch round wire, close wound, and 4 inches mean diameter, is used in tension subject to moderate vibration where the load is not known. How can it be ascertained whether the spring is overloaded or not? Referring to Table III, we find that the maximum deflection per coil of a spring of a given diameter is 1.040 inch. If the opening between the coils is less than  $1.040$  inch  $\div 2 = 0.520$  inch (2 being the factor of safety for moderate vibration), the spring is safe. The deflection always is directly proportionate to the load. For example, what will be the deflection of a spring 6 inches mean diameter, made of  $\frac{3}{4}$  inch round wire, when carrying a load of 1,000 pounds? From Table III we find that with a load of 2,770 pounds, the deflection per coil is 1.440 inch; then for 1,000 pounds the deflection per coil would be  $\frac{1.440 \times 1,000}{2,770} = 0.520$  inch.

The designing of springs, when using these tables, becomes simply a matter of multiplying the load the spring is to carry by a proper factor of safety and then selecting a resultant pressure in the tables; from this, the diameter of the wire and the deflection can be found readily. Dividing the deflection given in the table by the same factor of safety as was used for the load, will give the actual deflection per coil, and adding this value to the diameter of the wire will give the pitch for a compression spring. The number of coils will depend upon the amount of movement the spring requires, and knowing this, we divide the length of movement by the deflection per coil, which gives the number of effective coils, and then add  $1\frac{1}{2}$  coils for the ends. As a rule, the mean diameter of a helical spring should be from 8 to 10 times the diameter of the wire.

## CORRESPONDENCE CARD FOR MFG. PLANTS.

In large manufacturing plants communications between the different departments are numerous, and any scheme that saves time and unnecessary writing in such correspondence is worthy of attention. The accompanying reproduction shows the head of the correspondence card used by the Ingersoll-Rand Co. Only a word of explanation is required to make its

Form 13, 3-20-07, 5 M. H.

**INGERSOLL-RAND CO.**

**CORRESPONDENCE CARD.**

In Starting Card, Draw Line Through Your Name

From	10 Watchman	20 Auditor	29 Purchasing
1 Warehouse	11 Comp. Fore.	21 Chief Engineer	30 Store Room
2 Shipping	12 Manager	22 Pattern Storage	31 Hardening
3 Power Shop	13 Purchasing Agent	23 Electrical	32 Shop Repairs
4 Smith Shop	14 Foundry	24 Power	33 Carpenter
5 Drill Fore.	15 Com. Mach. Shop	25 Pneumatic Tool	34 Millwright
6 Drill Assem.	16 Drawing Room	26 Drill	35 Drill Testing
7 Superintendent	17 Order	27 Time	36
8 Tool Distrib.	18 Accounting	28 Inspection	37
9 Tool Room			

to 14 to to to to to to to to to to

Size of sheet, 6 x 9 $\frac{1}{2}$  inches.

use clear. It will be noted that a list of departments is printed on the head, with numbers. If the foreman of the pattern shop, for example, wishes to communicate with the foundry, he simply draws a line through his own department and writes the number of the department to which the communication is to be sent. That constitutes all the direction necessary and identifies the source of the communication. If the note is to be sent on to another department with memorandum, the first number can be crossed off and a second number written in the places provided. Thus to forward the note from the foundry to the machine shop the number 15 is written in, the previous number 14 being crossed off.

\* Address: 16 Merrifield St., Worcester, Mass.

### THE MANUFACTURE OF TAPS—1.

While the methods involved in the making of a tap in the tool-room, when only one or a few tools are made at a time, are comparatively simple, and well-known to tool-makers and mechanics, the processes employed in the manufacture of taps in large quantities are entirely different from those which would be employed by the tool-maker. A great deal has been published in *MACHINERY* during the last few years regarding the design and construction of taps, but comparatively little has been published in the technical journals

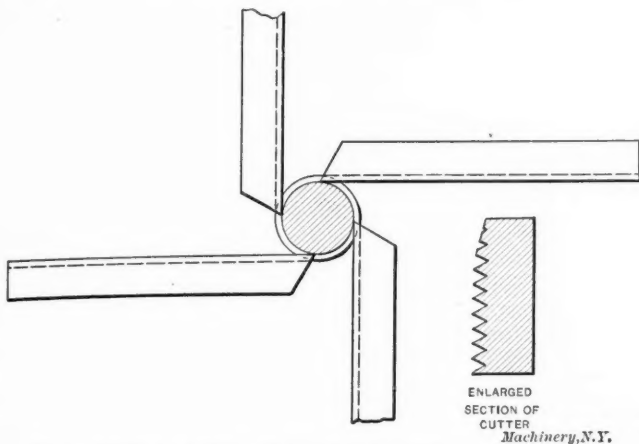


Fig. 1. Principle of Action of Dies with Inserted Chasers or Cutters, for Threading Taps.

regarding the actual manufacturing processes employed by leading tap manufacturers. *MACHINERY*, therefore, obtained permission from the Wells Bros. Co. of Greenfield, Mass., to send an editorial representative to visit the works with the object of presenting to the readers of *MACHINERY* an illustrated description of the works and the methods employed.

It may well be said that Greenfield, Mass., although a small town of only ten or twelve thousand inhabitants, is actually the seat of the tap and die manufacture of the country. There are about half a dozen different firms in this town manufacturing taps and dies, and it is stated that 75 per cent of the total of these tools used in the United States is manufactured in Greenfield. The output of the Wells Bros. Co. constitutes a considerable proportion of this percentage.

#### History of the Wells Bros. Co.

The Wells Bros. Co. was started in 1876 by Messrs. F. E. Wells and F. O. Wells, who, together with their father, Mr. E. Wells, commenced the manufacture of taps and dies in a small

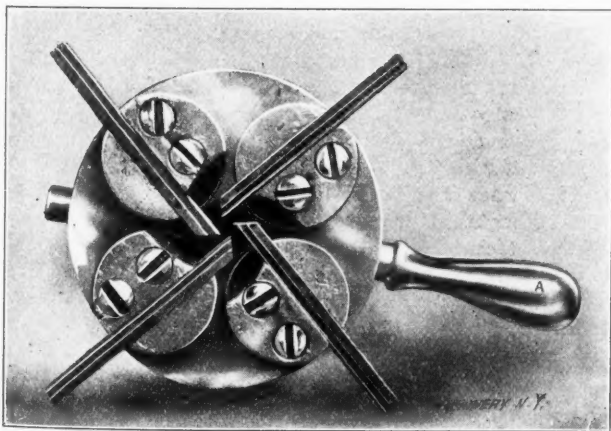


Fig. 2. Small Self-opening Die used for Threading Taps up to 3-8 inch Diameter, in Horizontal Machines.

factory. They began business with \$1,100, and it is one of the remarkable features about the up-building of this concern that it has grown up entirely from this original investment, no money having ever been borrowed for the increase of the factory and equipment. At first the brothers employed no help. During the first year they met with some difficulties; the old factory which they occupied burned down six months after they had started business. Among the valuable things

lost at that time was the tool chest of Mr. F. O. Wells, now president of the company, which contained a great many special tools employed in the making of taps, which he had been making for himself evenings, after having concluded the regular day's work. The brothers then hired a room in another factory for about a year, and, the business prospering, they concluded to erect a one-story brick building 25 x 50 feet, in 1877. From that time on there was an addition added every year, either on the top or on the sides of the original building, until the ground where this factory was erected was all covered, and further extension was impossible, or at least impracticable. In 1889, therefore, a new one-story factory 100 x 200 feet, with a power house 40 x 40 feet, was built on the present site of the works, and to this again an addition was added almost every year, except in 1893, until the present plant has reached the proportions of about 75,000 square feet of floor space. Although the factory has been added to in this manner from year to year, it presents at the present time a homogeneous appearance on account of being built in such a manner that units could be added without interfering with the general plans of the shop.

Mr. E. Wells retired from business in 1880, at which time Mr. F. E. Snow, the present treasurer of the company, entered the firm. Mr. F. E. Wells left the business and sold out his

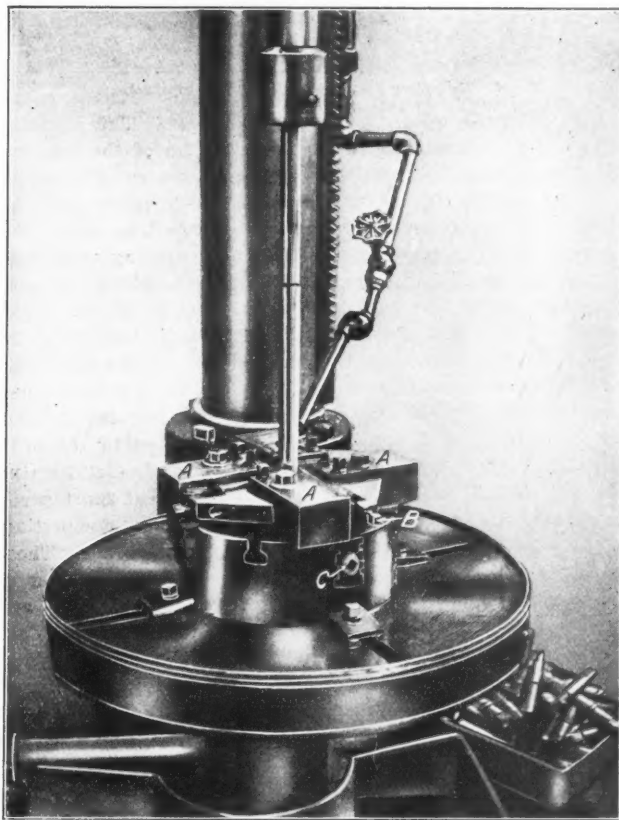


Fig. 3. Upright Tap-threading Machine used for Threading Stay-bolt Taps.

interest about five years ago, leaving Messrs. F. O. Wells and F. E. Snow in control of the Wells Bros. Company. The growth of the company is well exhibited by mentioning the fact that while only seven or eight men were employed in 1880, about one hundred men were employed when the new factory was built in 1889, and at the present time, when running full force, the company employs about 300 men.

This short historical sketch of the shops will give an idea of the gradual growth of the business. It can easily be inferred that the methods employed in the manufacture of taps and dies are of the best, considering the length of time that has been allowed for the development of new ideas and special machinery. The various tools and methods described below are practically all due to the inventive ability of Mr. F. O. Wells, who has been, and who still remains, the active mechanical head of the works. After these introductory remarks we are now ready to enter upon a detailed description of the manufacturing methods employed in the making of taps.

### Making the Tap Blank.

The ordinary method of turning up tap blanks in a lathe, from stock which is from 1/32 to 1/16 inch over the outside finished diameter of the thread, has been discarded except in the case of comparatively large taps, and simpler and more efficient methods adopted. Tap blanks up to 1 1/4 inch, or in extreme cases 1 3/8 inch, are turned and cut off from the bar in automatic screw machines. The bar is rolled to the finished size of the tap to be made plus 0.005 inch, the 0.005 inch being added to allow for unavoidable variations in the stock, and the over-size required in the finished tap; thus the bar

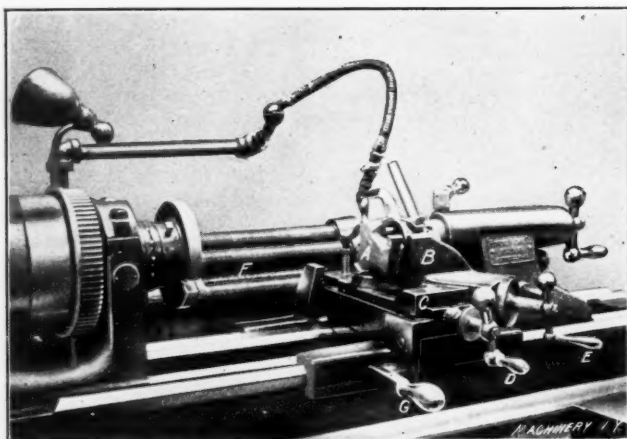


Fig. 4. Threading Lathe for Special Straight Taps.

for 3/4 inch taps is rolled to a size of 0.755 inch. This obviates the necessity of turning the threaded portion of the tap, the only part required to be finished in the screw machine being the shank, which is turned down to the required size by hollow milling. During this operation, as well as during all subsequent cutting operations except the threading operation, soda solution is used for lubricant. When threading the taps, the cutting tools and the taps are flooded with oil. Taps larger than 1 3/8 inch are made from the rough bar, which in this case is 1/32 inch over the finished size of the tap. The blank, however, is hollow milled and turned in a screw machine the same as in the case of the smaller tap blanks. Very large taps, of course, are turned in lathes in the ordinary way. Most taper taps are turned in special turning lathes provided with forming attachments so that the tapered portion and the shank of the tap can be turned at one setting, the operator being able to run a number of machines. These turning lathes are of comparatively small size, a number of head-stocks and tail-stocks being placed on the same bed and run from the same shaft in the back of the machine, each machine having a clutch permitting its individual drive to be thrown in and out independently. It is interesting to

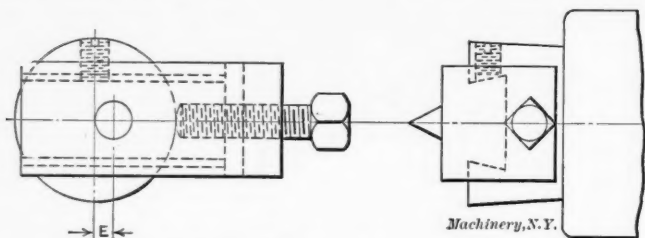


Fig. 5. Tail-center for Threading Lathes, permitting Slight Tapers to be obtained without Setting over Tail-stock proper.

note that while this system has only lately been introduced commercially for use in driving a number of small machines in factories working exclusively on small work, and in manual training schools, etc., it has been in use in these shops for over twenty years.

Large tap blanks are cut off in cold-saw cutting-off machines. In order to save time in cutting off, and use the cold-saws to their highest capacity, holders have been devised permitting a number of bars to be securely clamped together and cut off simultaneously. A special carrier mounted on wheels and running on a track made from inverted angle irons, is provided behind the machine, and the bars rest on these carriers. This makes it easy to feed the bars along when one set of blanks has been cut off.

All diameters of the shanks and bodies of the tap blanks are measured by limit gages of the type manufactured by Wells Bros. Co. (shown in the September, 1907, issue of MACHINERY), of which a full set is illustrated in Fig. 19. These limit gages are, in fact, in use all over the shop. Referring to gages A and B, Fig. 19, it will be noted that there are two sets of adjustable gaging pins, one over the other, and when measuring the diameter of the shanks of the taps, for instance, it is only necessary to pass the gage directly over the shank which should slip easily in between the two upper gage points which determine the maximum dimensions, while the shank should not pass through the two lower gage points which define the minimum diameter permissible. It is easily seen that in this way but little dependence is placed on the operator's judgment as regards permissible limits, and the gaging is done instantly both for maximum and minimum sizes. It is far superior to the common method of using a gage with the maximum dimension at one end and the minimum at the other, because this requires that the gage be reversed, and more than double the time is required for gaging.

It is evident that when the tap blanks are cut off in screw machines in the manner described, they have no centers in the ends, and some method must be adopted for providing correctly located centers to be used in subsequent operations. In order to do this, the teat on the end of the tap blank, which is left from the cutting-off operation in the screw machine, is first ground off, and then the center is drilled in a special centering machine. Considering the fact that the finished stock used for the taps is only 0.005 inch over size,

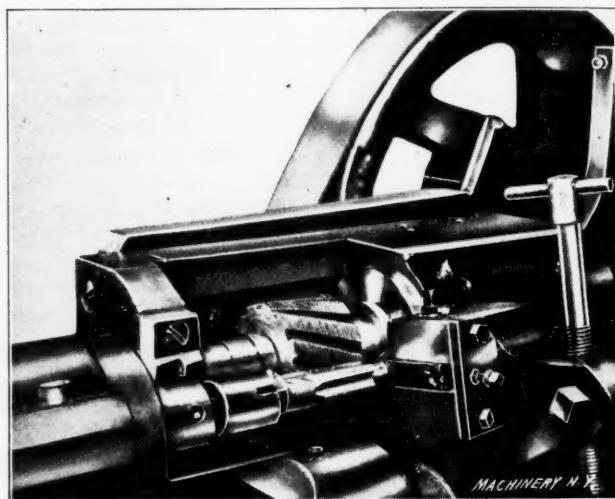


Fig. 6. Method of Threading and Relieving Ordinary Taper Taps, such as Pipe Taps, Boiler Taps, etc.

it is clear that the center must run perfectly true with the outside of the tap. An ordinary centering machine will hardly fill the requirements, but by the means adopted the object is easily accomplished. The tap blank is placed in a female center at one end which drives it, it being supported near the other end by an adjustable V-shaped rest. It is evident that when the tap blank revolves and the centering drill is brought up against it, the drill will either enter in the exact center of the blank or refuse to cut; if forced into the blank, although not being in the center, the drill, of course, would break. The adjustable V-rest is adjusted for the first blank in a set, until the operator sees that the blank is running true with the centering drill. He then drills the center of this blank, and can continue to put the centers in the remaining blanks of the same size with practically no attention other than putting shank end of the tap blank into the female center, placing the body of the blank in the V-rest, and feeding the centering drill into the other end. When a lot of taps has thus been centered at one end, the V-rest is adjusted so that the shanks run true in it, and the shank end of the taps is centered in the same manner.

### Threading.

The threading is one of the most important operations performed on a tap, and the methods employed in various tap manufacturing plants are of special interest for the rea-

son that a great many different processes are employed. The method employed by the Wells Bros. Co. consists in cutting the taps with dies, or rather with four threading tools placed in a die-holder. The principle of the action of the cutting tools and their relation to the tap being threaded is illustrated in Fig. 1. One of the die-heads, which also clearly illustrates the principle employed, is shown in the half-tone, Fig. 2. This die-head is used for small taps in a horizontal machine, and is provided with a self-opening device so as to permit the chasers or cutters to recede from the tap when this has been threaded, to permit it to be withdrawn from the die without reversal. The handle for the self-opening mechanism is shown at A in the illustration. Larger taps, say from  $\frac{3}{8}$  inch and up, are cut in machines with vertical spindles. In this case the tap passes clear through the die-head, and there is no self-opening adjustment for the dies; the chasers are inserted in holders which in turn are placed in a body, much in the same way as are the jaws of independent jaw chucks. There is an adjustment by means of a screw in the back of each chaser, and also an independent adjustment of each jaw in the chuck. One of these chaser-

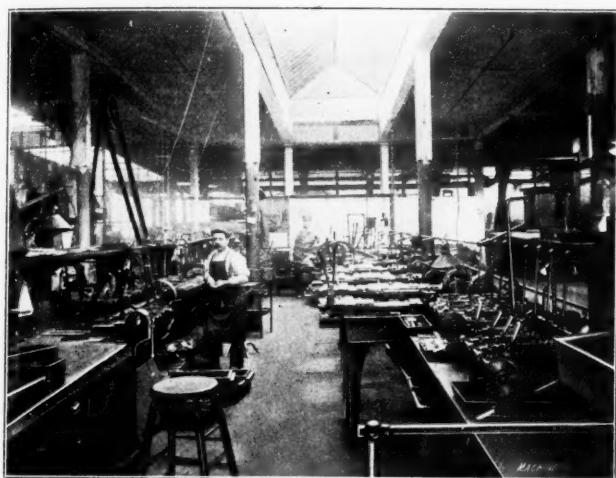


Fig. 7. View of the Special Threading and Relieving Department of the Wells Bros. Co.'s Shops.

holding chucks or dies used in an upright machine and intended for threading stay-bolt taps, is shown in Fig. 3. The jaws holding the chasers are shown at A, the adjusting screws back of the chasers at B, and the provision for the adjustment of the jaws is shown at C.

The threading operation is performed on a special drill press having a spring balanced spindle, oil being provided from a central distributing tank by a pump driven by an independent motor. The cutting portion of the chasers is chamfered like dies, except that the chamfer is rather longer than that on ordinary die chasers. The angle of the chaser

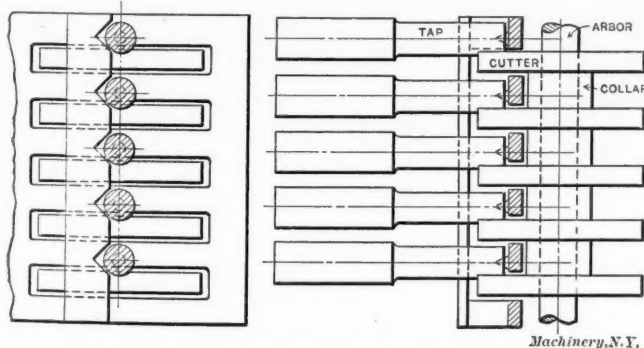
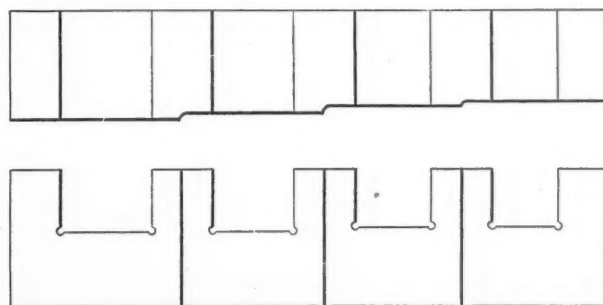


Fig. 8. Diagram showing Principle of Tap Squaring Fixtures.

between the cutting face and the front of the tool is about 60 degrees, and the cutting point, when the chasers are adjusted, is a little back of the center of the tap. The chasers are from five to eight inches long, according to the size of die-head for which they are intended, and are provided with threads or grooves the full length, cut at an angle corresponding to the diameter and pitch of the tap to be threaded. They are hardened, by heating in lead, for a distance of about one to one and one-half inch at a time. If hardened for the

full length at once, the distortion in hardening would make the chasers useless for accurate work.

With the exception of the machine shown in Fig. 3, for threading long taps, the other machines are multi-spindle tap threaders. They are all built by the company for its own use, and in general appearance they resemble ordinary drill presses. The small machines on which the threading is done horizontally, resemble horizontal tapping machines. On the



Machinery, N.Y.

Fig. 9. Gages for the Squares of Taps.

vertical machines the taps drop right through the die when the thread is cut, and on the machine shown in Fig. 3, where the taps threaded are very long, there is a hole in the floor permitting any length of tap within reasonable limits to be threaded. Ordinarily the taps pass through the dies two or three times, the last time a very light finishing cut only, being taken. The stay-bolt taps pass through the die only once, at a somewhat slower speed than used when threading taps which pass through several times. The speed by which taps can be threaded when this method is employed, is rather remarkable. A  $\frac{7}{8}$ -inch diameter tap having a length of thread of about  $4\frac{1}{2}$  inches can be finish threaded, passing through the dies three times, in about three minutes, while a stay-bolt tap having from 24 to 30 inches of thread is threaded in about five minutes.

#### Special Threading Lathes for Taps of Odd Size and Pitch.

When taps of odd size and pitch are to be made, it is not economical to rig up a machine with chasers held in holders

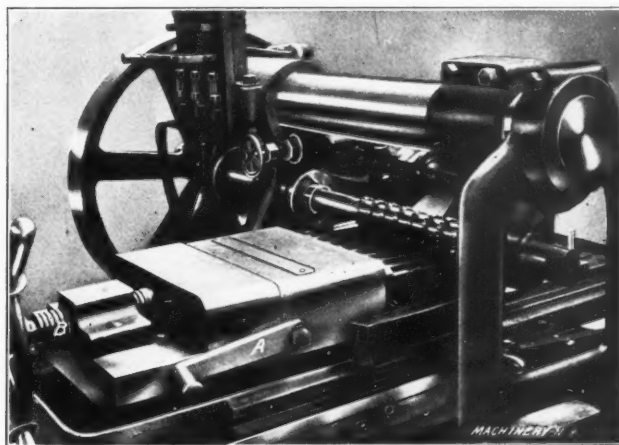


Fig. 10. Fluting Eight Taps at one Setting.

of the type described, because the making of the chasers, as well as their adjustment, requires considerable skill and time; consequently these chasers are only made when a great number of taps of the same diameter and pitch are required. For odd cases, therefore, the threading of the taps is done in special threading lathes, one of which is shown in Fig. 4. The chasers for cutting the thread are somewhat similar in appearance to those used in the die-heads already described, and three of these are held in a special swiveling thread-tool holder shown at A in Fig. 4. Of course, when held in this manner these chasers are really nothing but ordinary thread-cutting chasers. Three of the chasers are used in one holder for the reason that the thread in the tap is produced by three cuts, one roughing, one semi-finishing, and one finishing. The swiveling tool-holder is provided with stops so that the operator can easily and quickly turn the tool from the position required for the roughing tool to the position

required when either of the other tools is in operation, and the holder is rapidly clamped in position after the adjustment. The holder is mounted in a special tool-carrying slide *B*, operated by handle *E*. This upper slide *B* is moved in an angle relative to the slide *C*, which latter is fed inward at right angles to the axis of the lathe spindle by the handle *D*. The handle *E* of the upper slide is operated when it is required to adjust the tool in a longitudinal direction so as to suit exactly the pitch of the thread being cut, while the handle *D* is operated when the slide is fed in and out for taking a heavier or less heavy cut.

One of the interesting details in the construction of this machine is the arrangement of lead-screws. It will be noted that in the back of the machine at *F* a number of lead-screws of different pitches are provided. These are placed in a turret-like horizontal holder, held by brackets placed in the

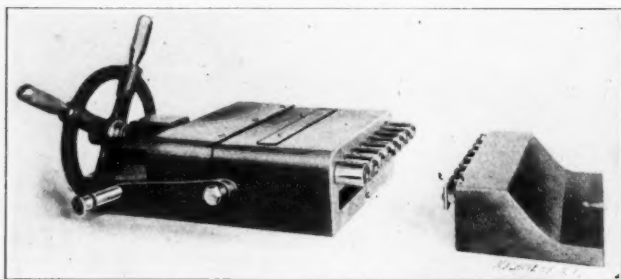


Fig. 11. Fluting Fixture shown in Place on Machine in Fig. 10.

back of the machine, and one lead-screw at a time engages with a half nut directly at the back of the carriage. Owing to the fact that the lead-screws are mounted in a turret, any one of these lead-screws, each having different pitch, can be placed in engagement with the half nut in the back of the carriage, this half nut, of course, being changed to suit the different screws. There are eight screws in the holder or turret containing them, and the pitch of each can be doubled by the use of a multiplying change gear at the head-stock.

The advantage of this arrangement is obvious, particularly with regard to the possibility of disengaging the lead-nut from the lead-screw and running the carriage back by hand, and still being sure to catch the thread in the tap being cut. The change for different pitches is also quicker than when change gears are used to effect the correct lead. The lead-screws are provided with special ratchet thread, perpendicular on one

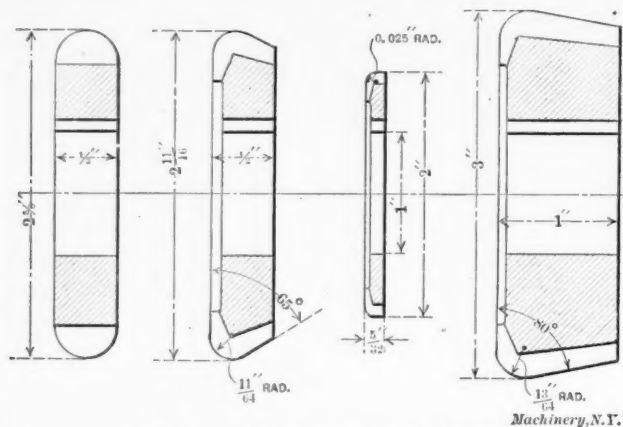


Fig. 12. Various Types of Fluting Cutters.

side and forming a 60-degree angle with the axis of the screw on the other. This form of thread largely obviates the difficulties due to too rapid wear of the threads in the lead-screw. In the front of the machine, at *G*, a handle is shown by means of which the tool slide can be moved back instantly so that the tool will be out of engagement with the thread cut, without interfering with the adjustment of the handle *D*. This improvement, which has lately been introduced in ordinary lathes of well-known manufacture, has been in use at the Wells Bros. Co.'s works for a great many years.

The taps threaded in these threading lathes are provided with a very slight back taper as commonly provided in taps of proper design. This taper is accomplished by moving the

tail-stock over a very slight amount. In some cases an improvement has been introduced in the tail-center whereby the necessity of moving the whole tail-stock over is obviated, and simply the center itself is moved over towards the front. In this case the center is placed on a small adjustable slide which in turn is held in a holder which is placed in the tail-stock. The adjustment for taper turning is then done directly by adjusting this center back and forth without interfering with the tail-stock proper. The general principle of this tail-center is shown in Fig. 5, where *E* indicates the amount the tail-center is moved out of alignment with the spindle of the lathe.

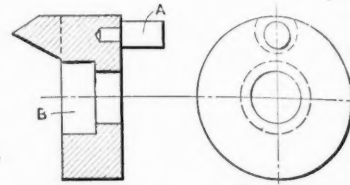


Fig. 13. Special Center for Tap Fluting Fixtures.

A slight amount of back taper is also provided in the taps cut by dies in the horizontal and vertical tap threading machines. This is accomplished by having the axes of the spindle and of the dies a very small amount out of alignment. Then as the tap travels downward through the die, the angle of deviation of the tap from the absolute vertical line will increase slightly as the distance between the spindle and the die is diminished, and the dies will cut the thread slightly smaller in diameter at the upper end, due to a kind of a wobbling action of the tap in the die.

#### Threading Taper Taps.

Taps of comparatively steep taper, such as pipe taps, are threaded in special threading machines, the most important parts of one of which is shown in Fig. 6. These taps are threaded by a hob which mills the full length of the thread at once and relieves it simultaneously, the flutes in the taps in this case being cut before threading. The grooves or

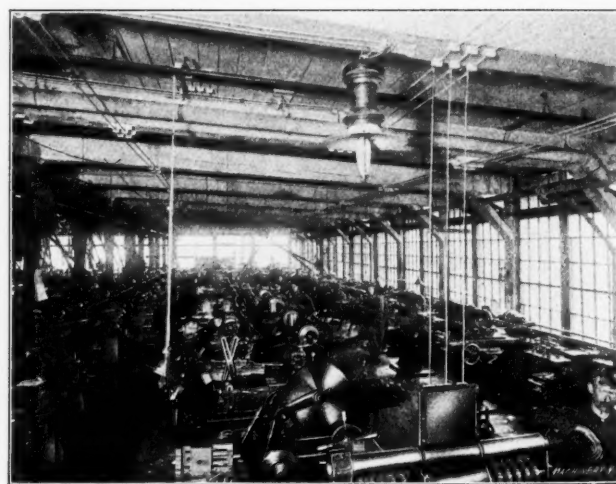


Fig. 14. Fluting, Squaring and General Milling Department.

threads in the hob are not cut with a lead, but form circular grooves around the hob; the flutes are cut on a helix in this hob. The tap moves along the hob, while rotating, according to the pitch required in the tap, and it is only necessary to revolve the tap two or three times to cut a complete thread produced, in fact, by a roughing and a finishing cut, as each time the tap revolves, a complete cut of the thread all over the tap is taken. It will be noted that the tap is squared before threading, and is held by the square at one end and by the center at the other. The center is adjustable, as shown, so that the tap can be placed in proper position to give the correct taper, the hob being straight. The relieving is accomplished by giving the hob an oscillating motion while the cut is taken. Of course, it is clear that the hob, in reality, is nothing but a combination of individual thread milling cutters placed together, each cutting one thread, but made in this case in one solid piece. The relief can also be accomplished by rocking the end of the tap held in the adjustable center, back and forth by a cam placed on a cam-shaft and geared in the proper ratio to the driving spindle of the machine into which the tap square is set.

Fig. 7 shows a general view of the department of the shop where the special threading and relieving machines are installed. This chamfering and relieving of straight taps, however, is, of course, not done before the taps are fluted, so that the taps leave this department after threading, to be squared and fluted, and are then returned to be chamfered and relieved on the chamfered portion.

#### Squaring the Taps.

The squaring of the taps is done in fixtures similar to those used for fluting, which are shown in Figs. 10 and 11, and cutters with inserted teeth are used for milling. The taps are squared only on one side at a time, as shown diagram-

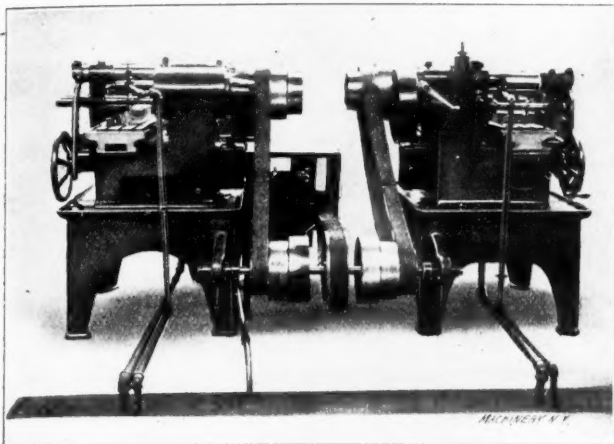


Fig. 15. Method employed for Driving Two Machines from One Motor—System of Piping for Oil and Electric Wires.

matically in Fig. 8, as many as eight taps, of some sizes, being squared at a time. The reason for squaring only one side at a time is that by so doing it is much easier to get the square exactly central with the axis of the tap, which is often not the case with taps which are squared with cutters which cut two sides of the square at once. The taps are fed longitudinally towards the cutters, so that while cutting the square, the center lines of the taps and the cutters form one continuous straight line. The size of the square is made exactly  $\frac{3}{4}$  times the diameter of the tap which is the commonly employed size of square with all leading tap manufacturers. A gage used for measuring the sizes of the squares of different sizes of taps is shown in Fig. 9. It will be seen that both the length and the size of the square are gaged at one time.

While squaring, the taps are held on male centers at the end being squared, and in female centers on the threaded

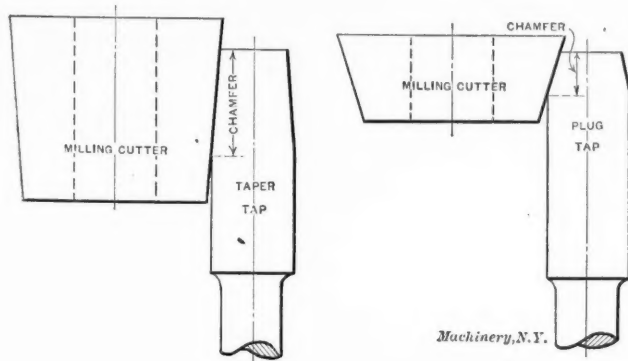


Fig. 16. Principle employed in Tap Chamfering and Relieving Machines.

end. The manner in which the centers are made in order to permit the milling cutters to pass closely by the center when squaring, is illustrated in Fig. 8. It will be seen that a small V-shaped groove is cut in a supporting plate below the tap shank. This is intended simply to support the tap when being put in place. When clamped between the centers, the tap, of course, does not rest in these V-supports.

#### Fluting the Taps.

When fluting, the taps are held in fixtures which take four, six, or eight taps at a time, according to the size of the taps. One of these fixtures, placed in the milling machine with

eight taps being fluted, is shown in Fig. 10; the fixture by itself is shown in Fig. 11. It is evident that in order to permit the milling cutter to pass as close to the center of the tap as possible when cutting the flute, half centers must be employed. It has been found, however, that the ordinary half center has its disadvantages, it being required to mill off so much on the top of the holder for the half center that it gives the center a comparatively poor support. For this reason an interesting type of center, as shown in Fig. 13, is used. The pin A locates the center in the holder, and the counterbored hole B is intended for a binding screw which passes through the body of the center and binds it firmly to the body of the fixture. The simplicity of this center is plainly in evidence; it is held rigidly and is stronger than the ordinary half center.

When milling the flutes, the taps are held on these centers at the threaded end and in tapered square female centers at the squared end. The taps are all tightened in place at once by one binding screw B, Fig. 10, and an equalizing device is employed to make all the centers bind the taps to an equal degree. In front of the male centers a strap is placed similar to that employed in front of the male centers on which the taps are held when squared. This strap is provided with small V-grooves in which the taps rest until they are clamped against the male centers by means of the hand-wheel and binding screw. The indexing is accomplished simultaneously for all the taps by the lever A, Fig. 10, which is connected with the spindles for the different taps by spiral and spur gearing. Of course, bevel gears can also be used instead of spiral gears for the transmission of the motion from the transversal stud on which the index lever is placed,

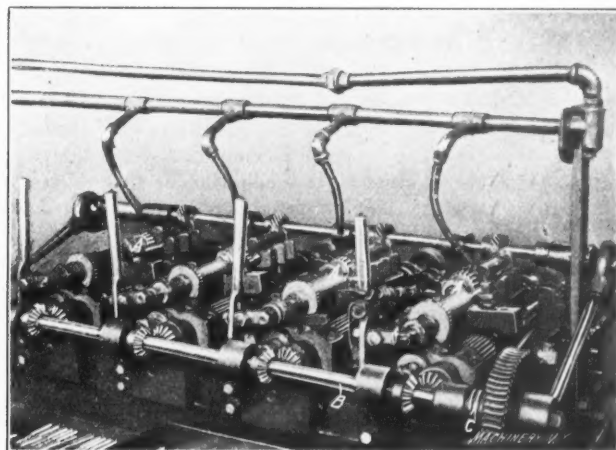


Fig. 17. Tap Chamfering and Relieving Machine with Eight Spindles, of which Four are shown in the Illustration.

to the spindles which are set in a longitudinal direction. There is only one index hole on the side of the fixture, one complete turn of the index lever being required to index one-quarter turn of the tap holding spindles. As most taps have four flutes, this device, therefore, answers the purpose without any index plates, and without the use of a number of different index holes. Mistakes in indexing are thereby completely avoided. Several different types of cutters used for fluting taps are shown in Fig. 12. The first type, which is an ordinary convex cutter, is used for stay-bolt taps. The dimensions given are for a cutter used for a one-inch tap. The second cutter from the left is used for regular hand taps, the size shown being used for a  $\frac{3}{4}$ -inch tap. The third cutter is used for machine screw taps and small hand taps,  $\frac{1}{8}$  inch in diameter and less. Finally, the cutter to the extreme right is used for pipe taps, the size shown being for 1-, 1 $\frac{1}{4}$ -, 1 $\frac{1}{2}$ -, and 2-inch taps.

A general view of the milling department is shown in Fig. 14. Directly in the foreground will be seen a machine for squaring ten taps at once, two fixtures being employed, each holding five taps, one on each side of the machine. It will be noticed that over-head counter-shafts are largely done away with in this department of the shop, and most machines are driven by individual motor drives. In some cases one motor is employed for driving two machines, and in other cases there are counter-shafts placed on the floor in the back

of the machines, the object being to do away with over-head belting and line shafting.

Fig. 15 shows a simple and effective manner of coupling two machines to one motor, thus avoiding an excessive amount of counter-shafting and at the same time occupying no space that could be utilized for other purposes. It will be noted that the motor is placed in the background (which is really the front side of the machines) between the two machines which are turned end to end, having their fronts in opposite directions. Over the motor, as can be seen, is placed a bench on which work and cutters can be put. In this way

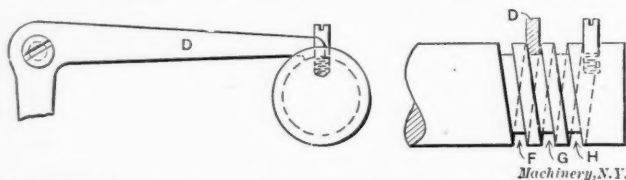


Fig. 18. Ingenious Automatic Trip for Drive of Chamfering Machines.

the space occupied by the motor is utilized for a purpose for which space would be required in any event, and in a sense the motor does not occupy any space at all, inasmuch as the bench placed over it would be required whether the motor was under it or not. In the same illustration is also shown the manner in which the wires and oil are carried to and from the machines. The floor is made of concrete and provided with grooves or ducts covered by cast iron plates, as shown in the foreground of the illustration. The pipes supplying the lubricant to the cutting tool as well as the pipes carrying off the used lubricant, are seen emerging from the duct through the cast iron plates at both the right- and left-hand side, while the single pipe seen in the middle entering through the cast iron plate into the duct, contains the wires for the power.

#### Chamfering and Relieving Taps.

The chamfering and relieving on the chamfered portion of ordinary straight taps is accomplished in special machines, and the principle involved in this operation is best illustrated by the line engraving Fig. 16 where two taps are shown, one taper and one plug tap being chamfered by milling cutters of different tapers. As will be seen, the whole length of the chamfer is cut at once by a milling cutter, and the tap is moved or rocked eccentrically while the cut is taken on each

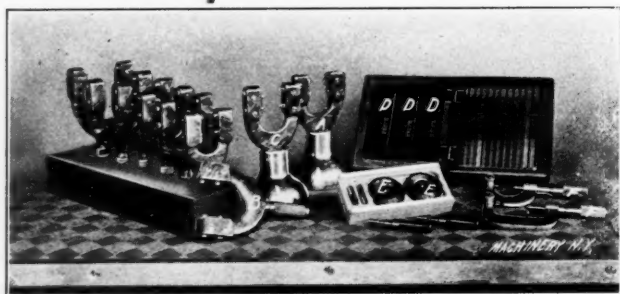


Fig. 19. Limit Gages and Gages for Testing Lead, used in the Shops for Working and Inspection Gages.

land so that the relief on the chamfered portion is produced simultaneously with the chamfer itself. The tap is held by the square in a chuck and on a center at the other end while this operation is performed and is mounted in a head which is journaled so that it can be swiveled or rocked by a cam. These chamfering machines, as shown in the right-hand foreground in Fig. 7, are built in units having eight spindles each; half of one of these machines is shown in enlarged scale in Fig. 17. Here the cutters which produce the chamfer are shown at A while the taps are practically hidden by the other parts of the machine. Oil or other cutting fluid is carried to the cutters by an oil pipe supplied from a central source.

These machines are also provided with an interesting automatic stop which permits the operator to set the machine so that the cutters will go around the tap one, two, or three times, according to the requirements, before the drive is thrown out of engagement. The principle of this stop is shown in Fig. 18. It consists simply of a lever sliding in a

helical groove on the driving shaft B in Fig. 17. The part with the helical grooves is shown in the same illustration at C. At one end of the helical groove the lever strikes against a screw and thereby trips another lever, by means of which the drive is thrown out of engagement. When the machine is started the operator can place the end of the lever D, Fig. 18, in either of the grooves F, G, or H, and it is evident that when placed in the groove F, the shaft must revolve three times before the machine will be tripped, whereas, if placed in groove G, it will revolve only twice, and when placed in groove H only once before tripping. This is a very simple and ingenious scheme for automatic and adjustable tripping of a machine of this description.

#### Marking the Taps.

For marking the taps, a number of devices working on the principle of an ordinary printing press are employed. The taps simply roll under the die containing the characters to be impressed in the tap shank, pressure being exerted on this die so as to give a clear and distinct marking on the shank.

The taps are now completed as far as the machining operations are concerned. They are inspected between each of the more important operations, particularly after the threading, the gages used for inspection being shown in Fig. 19. In this illustration the gages used for measuring plain cylindrical work, already referred to, are shown at A and B, and a gage of the type used for measuring the angle diameter of the thread is shown at C. Gages for measuring the correct lead are shown at D and micrometer gages used for sizes where no limit gages are available, at F. These limit gages are also supplied to each of the men performing the work on the taps, so that he can easily determine whether the work is done properly or not. In a coming issue of MACHINERY the hardening and final inspection of the taps will be treated, together with a description of other features of interest in the Wells Bros. Co.'s shops.

E. O.

\* \* \*

An interesting list of the largest steamships afloat is given in *International Marine Engineering*. The growth of steamships is also referred to. It is interesting to note that the average length of the twenty largest steamships in the world in 1848 was 230 feet; and in 1873, twenty-five years later, the average was 390 feet. After another quarter century, the average of the twenty largest liners was 541 feet, whereas now the average length is 700 feet. If we include the two new White Star liners, the building of which has just been begun, the list of the thirty largest steamships is as follows:

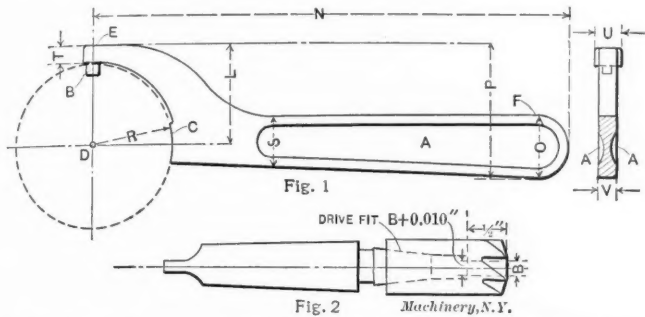
SHIP.	Launched.	Line.	Length, Feet.	Gross Tonnage.
1 Olympic*	1910	White Star.....	860	42,000
2 Titanic*	1910	White Star.....	860	42,000
3 Mauretania	1906	Cunard.....	760	31,938
4 Lusitania	1906	Cunard.....	760	30,822
5 George Washington†	1909	North German Lloyd.	700	24,800
6 Kais. Augusta Victoria.	1905	Hamburg-American...	678	24,581
7 Adriatic	1906	White Star.....	709	24,541
8 Rotterdam	1907	Holland-America.....	650	24,176
9 Baltic	1904	White Star.....	709	23,876
10 Amerika	1905	Hamburg-American...	669	22,225
11 Cedric	1902	White Star.....	681	21,035
12 Celtic	1901	White Star.....	681	20,904
13 Minnesota	1904	Great Northern.....	622	20,718
14 Caronia	1905	Cunard.....	650	19,687
15 Carmania	1905	Cunard.....	650	19,524
16 Kaiser Wilhelm II.	1902	North German Lloyd.	684	19,361
17 Kronprinzessin Cecilie.	1907	North German Lloyd.	684	19,360
18 President Grant.....	1907	Hamburg-American...	600	18,074
19 President Lincoln.....	1907	Hamburg-American...	600	18,074
20 Lapland†	1908	Red Star.....	620	18,000
21 Oceanic	1899	White Star.....	686	17,274
22 Prinz Friedrich Wilhelm	1907	North German Lloyd.	590	17,082
23 Nieuw Amsterdam.....	1906	Holland-America.....	600	16,913
24 Deutschland	1900	Hamburg-American...	661	16,502
25 Cincinnati†	1908	Hamburg-American...	580	16,400
26 Cleveland†	1908	Hamburg-American...	580	16,400
27 Arabic	1903	White Star.....	601	15,860
28 Republic	1903	White Star.....	570	15,378
29 Kronprinz Wilhelm.....	1901	North German Lloyd.	637	14,908
30 La Provence	1906	French.....	603	14,744

Ships not yet afloat are marked (\*); those afloat but not yet in service (†).

In this connection it may be remarked that the gross tonnage of a ship is the cubic contents of the vessel below the deck, one ton being considered as equal to 100 cubic feet. The net tonnage is the cubic contents of the vessel when the space occupied by the machinery, quarters for the crew, etc., has been deducted. The displacement is the actual weight in long tons of the vessel.

THE MAKING OF SPANNER WRENCHES.

The qualities required in a spanner wrench are, in the first place, that it should correctly fit the working parts for which it is intended, and secondly, that it should be strong, light in weight, and neat in appearance. The appearance of the spanner wrenches, the making of which is described in the following, is shown in Fig. 1, where the outline of the nut for which the wrench is used is shown in dotted lines. The wrench blank should be drop forged, so that it is practically finished, except for the dimension of the pin B and the surface C. The pin is then subsequently finished by milling, as will be referred to later, so that it may fit snugly in the required size hole in the nut for which it is intended, and the surface C



Figs 1 and 2. Spanner Wrench and Hollow Mill for Finishing Spanner Pin.

is milled off to give the correct diameter from the center D, which, of course, is also the center of the nut, for which the wrench is used. It is evident that by drop forging the lug C so that it extends far enough out from the body of the wrench, the same drop forging can be made to suit a number of different sizes of nuts, within a certain range, depending upon how much of this lug is milled off in finishing surface C. In the drop forging, raised letters can also be provided in the hollow portion A of the handle, these letters giving the name of the maker, the size of the wrench, etc. This not only adds to the neat and finished appearance of the wrench, but, at the same time, produces a cheap means of marking the maker's name on every wrench, and of recording the size for which it is intended. The pin B should always be made solid with

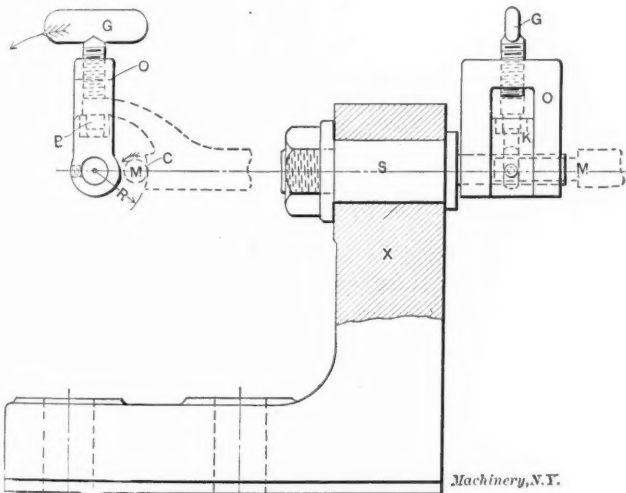


Fig. 3. Fixture for Milling Seat for Nut on Wrench.

the wrench. Inserting a loose pin, as is the custom of some makers, usually causes trouble, as the pin is liable to work loose or break.

The drop forged blank, when delivered from the forge shop to the machine department, is taken first to the drill press. The first operation is to finish the pin B to proper diameter, which is done with a solid hollow mill, it not being possible to use an adjustable hollow mill, because there would be no room in milling for the adjusting collar. The mill, as shown in Fig. 2, is rounded or relieved on the end to conform to the radius R of the wrench, so as to clear the body of the wrench when milling. The hollow milling operation is performed in a drill press, the wrench being held in a vise, resting on the surfaces E and F, while the as yet unfinished surface C acts

as a stop against a pin driven into one of the vise jaws. Allowance must, of course, be made in locating this stop pin for the difference in radius in the rough forging and the finished radius R of the surface of C.

When the vise has been correctly set on the drill press table, it is clamped in position, and the drill press table itself is clamped in place. If the setting is not disturbed, all the wrenches of the same size will then have the pin B hollow milled in proper relation to the surface C.

The next operation is to finish the surface C to the correct radius R. The manner of performing this operation is shown in Fig. 3. The surface C is finished by milling with an end mill M, using the fixture shown for obtaining the proper radius. The fixture is mounted on the milling machine table, but can be used by fastening it to the cross-slide of a lathe, and the end mill M mounted in the spindle. When the fixture has once been set in proper relation to the spindle of the machine, whether it be on a milling machine or a lathe, all slides are secured, so that no accidental motion of the slides will take place, in order to insure all the wrenches being milled alike. It is very essential that the circular surface of C be correct in relation to the pin B, as these are the elements of the wrench which fit the nut. If the end mill is sharpened, and its diameter thus reduced, it will be necessary to reset the table in relation to the spindle of the machine, in order to retain the radius R on the wrench.

GENERAL DIMENSIONS OF SPANNER WRENCHES.

See Fig. 1 for notation used in Table.

Dimensions of Nut for which Wrench is used.		R	Maximum Diameter of Pin B.	N	L	P	O	S	T	U	V
Diam.	Min. Width.										
1 1/4	1 1/4	9/16	5/8	5	1 1/4	1 1/4	1 1/4	7/8	3/4	3/4	3/4
1 1/2	1 1/2	1 1/8	3/4	5	1 1/2	1 1/2	1 1/2	7/8	3/4	3/4	3/4
1 3/4	1 3/4	1 1/8	3/4	5	1 3/4	1 3/4	1 3/4	7/8	3/4	3/4	3/4
2	2	1 1/8	3/4	6	2	2	2	7/8	3/4	3/4	3/4
2 1/4	2 1/4	1 1/8	3/4	6	2 1/4	2 1/4	2 1/4	7/8	3/4	3/4	3/4
2 1/2	2 1/2	1 1/8	3/4	6	2 1/2	2 1/2	2 1/2	7/8	3/4	3/4	3/4
2 3/4	2 3/4	1 1/8	3/4	6	2 3/4	2 3/4	2 3/4	7/8	3/4	3/4	3/4
3	3	1 1/8	3/4	6	3	3	3	7/8	3/4	3/4	3/4
3 1/4	3 1/4	1 1/8	3/4	7	3 1/4	3 1/4	3 1/4	7/8	3/4	3/4	3/4
3 1/2	3 1/2	1 1/8	3/4	7	3 1/2	3 1/2	3 1/2	7/8	3/4	3/4	3/4
3 3/4	3 3/4	1 1/8	3/4	7	3 3/4	3 3/4	3 3/4	7/8	3/4	3/4	3/4

The principle of the device will easily be seen from the illustrations. The wrench is placed in the fixture and held by screw G bearing on the top of the wrench directly over the pin B, which, in turn, fits in a hole in a block K, so that the wrench is thereby held securely in position. The block K, in turn, is placed between the ends of a fork O in which the screw G is inserted. Bushings provided with different sized holes to take different sizes of pins B are inserted in the block K, these bushings, of course, all having the same outside diameter. The yoke O and the block K are both mounted on an extension of the stud S, which is fastened to the bracket X clamped to the milling machine table.

It will be seen that the handle of the wrench itself is used as a lever for the hand feed when the surface C is milled. The operator holds the wrench so that the mill, which should run in the direction indicated in Fig. 3, starts in cutting at the lower edge of C; the wrench is then fed slowly until the surface C is machined. As yoke O and block K are pivoted at what would be the center of the nut, for which the wrench is intended, it is evident that the mill M will cut a surface that will fit this nut accurately. When the surface C is finished, the thumb-screw G is loosened, the yoke O is swivelled towards one side, as indicated by the arrow, and the wrench is simply lifted out. The pieces O and K could, of course, be made solid with one another, but this would necessitate unscrewing the thumb-screw G for the whole length of the pin B, so as to permit the lifting out of the pin from its seat in K. This would consume an unnecessary amount of time. This method for finishing the surface C of a spanner wrench is, without question, the simplest that the writer has seen used anywhere. The most commonly used method employed in

finishing surface C, even in so-called up-to-date shops, is by means of holding the wrench on a lathe face-plate and jacking off the surface by means of a turning tool.

The next operation to which the wrench is subjected is the filing off of the burrs left by the milling operations, and the polishing of all surfaces except the hollow surface A, Fig. 1. The polishing is generally done by means of a belt charged with emery, in a regular belt polishing frame, the belt permitting the polishing of all curves, nicely. This is very important, as nearly all parts of the wrench are curved one way or another. Hardly any other means of polishing would be permissible on account of the time required. The polishing, however, is hardly necessary when considering the nice surface left by the drop forging operation, but most firms turning out high grade work, polish spanner wrenches in order to add to the neatness of the appearance of the tool and to permit that nice finish on the polished surfaces, which a "case-hardening for colors" produces, to show properly.

The wrench should be case-hardened in a mixture of 10 parts of charred bone, 4 parts of charred leather, 6 parts of charcoal, and one part of powdered cyanide potash. These ingredients should be thoroughly mixed together and the wrenches laid separately in a box, so that they are not in contact with each other at any point. A cover is put on the box to keep out the air. The box is then heated until the wrenches reach a good cherry red color, the length of time, of course, depending upon the size of the wrenches and the box. Then the whole contents of the box, both mixture and wrenches, are dumped in clear water, care being taken that the wrenches pass through the air for a short distance before striking the water.

The accompanying table will give a general idea of good proportions of these wrenches. The dimensions, of course, are given merely for guidance, as wrenches of this type must be made in many cases to suit special requirements. The total length, however, and the general appearance and proportions, will probably prove valuable to those having to determine upon the design of spanner wrenches. A.

\* \* \*

#### ARTISTIC BLACKSMITHING.

Longfellow's beautiful poem, "The Village Blacksmith," strikes a responsive chord in most human hearts familiar with the sights and sounds of the rural smithy. It is a paean



Fig. 1. Wonderful Example of Skill in Forging.

to labor, exulting in honest toil and the sense of independence of a master workman:

"His brow is wet with honest sweat,  
He earns whate'er he can,  
And looks the whole world in the face,  
For he owes not any man."

The sentiment of the verse is honesty, strength, industry; and it admirably expresses the common regard in which the blacksmith is held. There is in it no hint that the blacksmith's art can be the means of artistic expression; the smith is not there pictured as one on the plane with the sculptor. His work is too ordinary and too useful to be classed with the creations in clay, marble and bronze symbolizing lofty sentiments and deeds of valor. The blacksmith has always been a doer and provider; he is the oldest of craftsmen and

enjoys the distinction of being the only one who *can* make all his own tools, as well as the tools for others. His may appear rude and clumsy, but they suffice unto his needs, and that is enough. But that these rude tools in the hands of a master may become the means of finer expression, calling into being creations in iron that almost rival nature's own handiwork in delicacy of tracery and beauty of outline, is the object of this tribute to the skill of one who daily earns his living at the forge.

The pieces here illustrated are beautiful examples of "sculpture in iron," requiring skill and technique that put the carver



Fig. 2. Rose Branch with Roses, hammered out in Fourteen Hours.

of mere marble to shame when one considers the practical difficulty of the work. One illustration shows a rose branch sixteen inches long and nine inches wide on which there are two buds and two blooming roses. An idea of the delicacy of the work is gained from the weight, it being only thirty-three and one-half ounces. The illustration brings out the delicacy of detail and fidelity to form in the original, and speaks for itself. It should be known, too, that this is no creation on which weeks or months of painstaking labor were spent; fourteen hours is the shop time required.

The first piece shown is even more artistic, and it has the added merit of being useful. It is a card tray or an ash receiver, the tips of the leaves and the stem acting as the supports. It represents a large leaf with a rose spray twined along the edge, there being one bud and a full blooming rose exquisitely formed. These pieces were forged, fashioned and welded in Swedish iron by our contributor, Mr. James Cran, foreman blacksmith of the Pond Machine Tool Works, Plainfield, N. J., and are samples of the work he does occasionally to delight his friends and to fill in the odd moments of a busy life.

\* \* \*

Following the establishment of two-cent first-class postage between the United States and Great Britain, comes the agreement between the United States and German postal authorities for a two-cent per ounce rate on first-class postal matter routed direct. The new agreement provides that after January 1, 1909, letters for Germany paid at the reduced rate of two cents will be dispatched only on steamers sailing from New York to German ports and *vice versa*. Letters from Germany by way of Great Britain or France must pay the five cent rate for the first ounce and three cents for each additional ounce.

## JIGS AND FIXTURES—10.

EINAR MORIN.\*

## PRINCIPLES OF BORING JIGS.

Boring jigs are, at the present time, as commonly used as drill jigs, in interchangeable manufacture, and the requirements placed on drill jigs apply in nearly all respects to boring jigs. Boring jigs are generally used for machining holes where accuracy of alignment and size are particularly essential, and also for holes of large sizes where drilling would be out of the question. Two or more holes in the same line are also, as a rule, finished with the aid of boring jigs.

The boring operation is performed by boring bars having inserted cutters of various kinds, and boring jigs are almost always used in connection with this kind of boring tool, al-

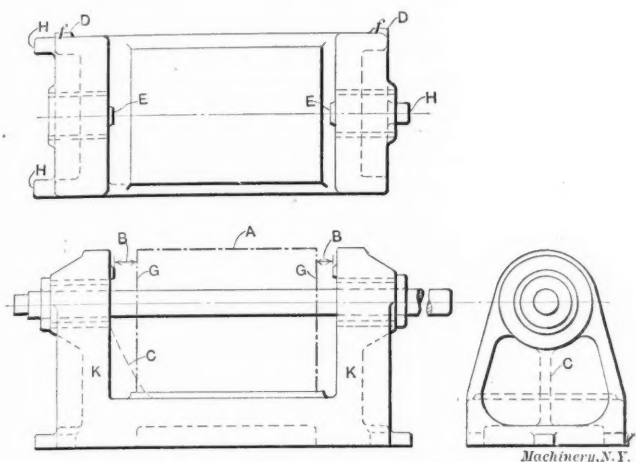


Fig. 109. General Outline of Simple Boring Jig.

though boring operations may be satisfactorily accomplished with three or four lipped drills and reamers. The reamers may be made solid, although most frequently shell reamers mounted on a bar and guided by bushings are used. The majority of holes produced in boring jigs, whether drilled or bored out, are required to be of such accuracy that they are reamed out in the last operation.

The boring-bars are usually guided by two bushings, one on each side of the bored hole, and located as close as pos-

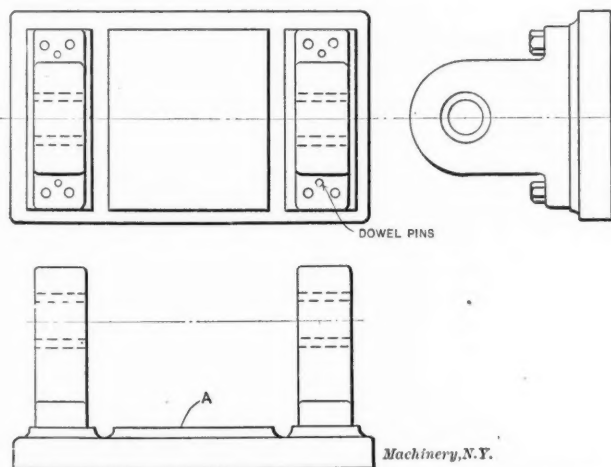


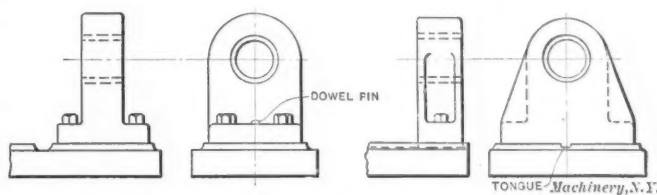
Fig. 110. Boring Jig with Base separate from Side Standards.

sible to each end of the hole being bored. The bar is rotated and simultaneously fed through the work, or the work with its jig is fed over the rotating bar. Boring jigs may be used either in regular boring lathes, in horizontal boring and drilling machines, or in radial drills.

The jig body is made either in one solid piece or composed of several members the same as in the case of drill jigs. The strain on boring jigs is usually heavy, which necessitates a very rigidly designed body with ribbed and braced walls and members, so as to allow of the least possible spring. As boring jigs when in operation must be securely fastened to the

machine table, means must also be provided in convenient and accessible places for clamping the jig without appreciably springing it.

The places in the jig where the bushings are located should be provided with plenty of metal so as to give the bushings a substantial bearing in the jig body. Smaller jigs should be

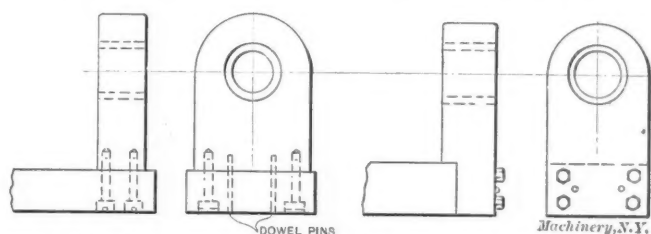


Figs. 111 and 112. Different Methods for Securing and Locating the Uprights on Base Plate of Boring Jigs.

provided with a tongue or lip on the surface which is clamped to the machine table; this permits the operator to quickly locate the jig in the right position. As an alternative, finished lugs locating against a parallel or square may be provided. It is frequently advantageous to have small sized boring jigs provided with feet so that they can be used on a regular drill press table in cases where holes to be bored out are to be opened up with a drill piercing the solid metal. It is both easier and cheaper to do this rough drilling in a drill press.

The guide bushings, of the same type as the bushings for drill jigs, are made either of cast iron or steel and ground to fit the boring-bar which is also ground. The bars are made of machine steel and should be made as heavy as possible, in order to prevent them from bending or springing too much should there be a heavier cut on one side than on the other. The bushings should be made rather long to insure good bearing.

The most common type of boring jig for small and medium size work is shown in Fig. 109. In this engraving, A represents the work which is held down by straps or clamps. In



Figs. 113 and 114. Alternative Methods for Fastening Uprights to Jig Base.

many instances when the work is provided with bolt and screw holes before being bored, these holes are used for clamping the work to the jig. In some cases it is important that the work be attached to the jig in the same way as it is fastened to its component part in the machine for which it is made, and also that it be located in a similar way. If the work is located by V-slides when in use on the machine, it is preferable to locate it by V's in the jig. In other cases the locating arrangement for the work in the machine where it is to be used may be a tongue, a key, a dowel pin, a finished pad, etc. The same arrangement would then be used for locating it in the jig. In Fig. 109 enough clearance is left at B, at both ends, to allow for variations in the casting and to provide space for the chips; also, if the hole is to be reamed out, and the reamer be too large to go through the lining bushing, then the space left provides room for inserting the reamer and mounting it on the bar. In nearly all cases of boring, a facing operation of the bosses in the work has also to be carried out and provisions must be made in the jig to permit the insertion of facing tools.

A great deal of metal may be saved in designing heavy jigs by removing superfluous metal from those parts where it does not materially add to the strength of the jig. In Fig. 109, for instance, the jig can be cored out in the bottom and in the side standards as indicated, without weakening the jig to any appreciable extent. The rib C may be added when necessary, and when it does not interfere with the work to be finished in the jig. It will be seen that extended bosses are carried out to provide long bearings for the bushings. The bosses may be made tapering, as shown, providing practically the same

\* Address: Borlänge, Sweden.

stiffness as a cylindrical boss containing considerable more metal. They must be given a rather liberal diameter, as they may not always be placed exactly correct on the pattern, and consequently be a little out of center in the casting. Finished bosses should be located at suitable places to facilitate the laying out and the making of the jig, as shown at *D* in Fig. 109. The finished faces of these bosses are also of advantage when locating the jig against a parallel, when it is not provided with a tongue for locating purposes.

In some cases bosses are placed where measurements may be taken from the finished face to certain faces of the work,

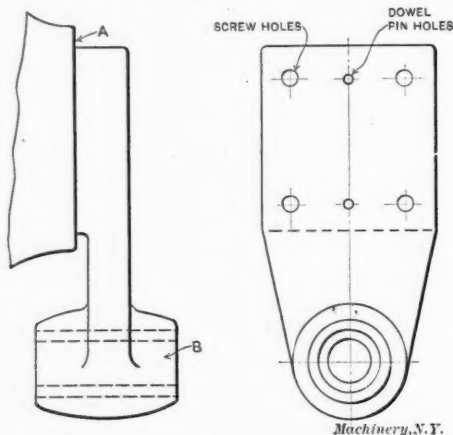


Fig. 115. A Case where the Bushing Hole is Bored Previous to locating and fastening Bracket on Jig Body.

in which case the finished bosses, of course, must stand in a certain relation to the locating point; such bosses are indicated at *E*, from which measurements *B* can be taken to surfaces *G* on the work. The three lugs *H* are provided for clamping purposes, the jig being clamped in three places only to avoid unnecessary springing action. If the jig is in constant use, it would be advisable to have special clamping arrangements as component parts of the jig for clamping it to the table, thereby avoiding loss of time in finding suitable clamps.

The walls or standards *K* of large jigs of this type are frequently made in loose pieces and secured and dowelled in

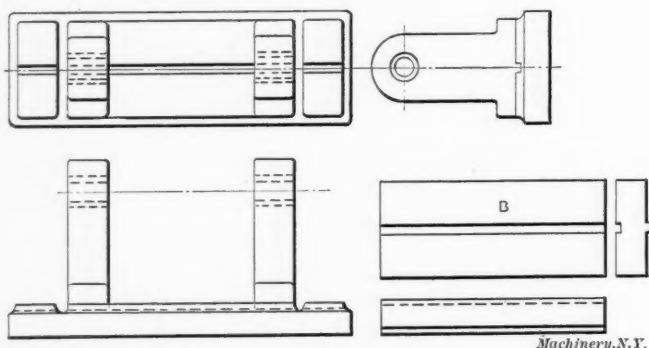


Fig. 116. Jig adjustable for Different Sizes of the Same Class of Work.

place as shown in Fig. 110 to 114. In such a case the most important thing is to fasten these members firmly to the base, preventing shifting by tongues, keys, or dowels. It is evident that when the standards are made loose as in Fig. 110, it is easier to finish the pad *A* of the face, and this is of importance, particularly when difficult locating arrangements are planned or milled in the face; the pattern-maker's and the molder's work is also simplified. As a rule the standards are screwed to the face permanently and then the bushing holes are bored. In some cases, however, it may be easier to first bore the hole in a loose part, and then attach it to the main body. Such an instance is shown in Fig. 115. It is easier to locate the bracket with the bushing *B* by working from the finished hole in connection with other important holes or locating means, than it would be to first screw the bracket in place and then expect to be able to get the hole to be bored, located exactly in the center of the hub of the bracket.

When boring jigs are designed for machine parts of a similar design but of different dimensions, arrangements are often

made to make one jig take various sizes. In such a case one or both standards may have to be moved, and extra pads are provided on the face as illustrated in Fig. 116. This shifting of the standards will take care of different lengths of work. Should the work differ in height, a blocking piece *B* may be made as indicated in the same illustration. Sometimes special loose brackets may be more suitable for replac-

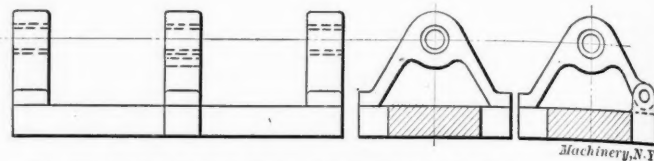


Fig. 117. Boring Jig with Removable Bearing in the Center, adapting it to Different Sizes of Work of Similar Character.

ing the regular standards for shorter work. If there is a long distance between two bearings of the work, a third standard may be placed in between the two outside ones, if the design of the bored work permits, as shown in Fig. 117; this may then be used for shorter work together with one of the end standards. In Fig. 118 is shown another adjustable boring jig. Here the jig consists of two parts *A* mounted on a common base plate or large table provided with T-slots. The work *B* is located between the standards. A number of different standards suitable for different pieces of work may be used on the same base plate. The jigs or standards are held down on the base plate by screws or dowels, and generally located by a tongue entering the upper part of the T-slots.

In the examples thus far given the work has been located on the jig, but it is apparent that boring jigs are frequently

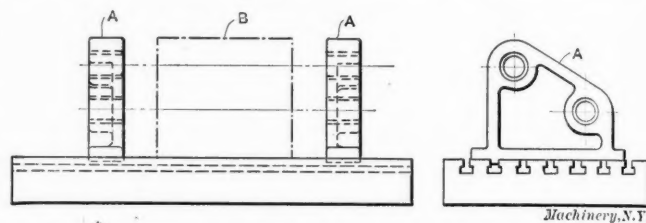


Fig. 118. Universal Base Plate for Standards of Various Descriptions for Different Classes of Work.

made which are located and supported on the work. Fig. 119 shows such a jig. The work *A*, which in this case represents some kind of a machine bed, has two holes bored through the walls *B* and *C*. This jig may guide the bar properly if there be but one guide bushing at *E*, but it is better if it can be arranged to carry down the jig member *D* as indicated to give support for the bar near the wall *B*. It may sometimes be more convenient to have two separate jigs located from the same surfaces on the top or sides. In other cases it may be better to have the members *D* and *E* screwed in place instead of being solid with *E*, and in some cases adjustable. Of course, these variations in design depend on the conditions involved, but the principles remain the same. The jig or jigs are held to the machine on which they are used by clamping arrangements of suitable type.

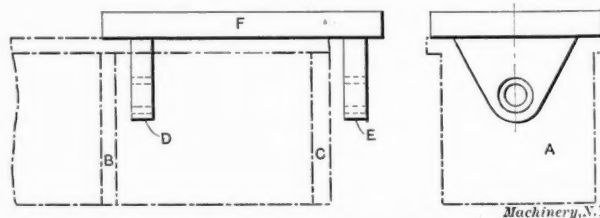
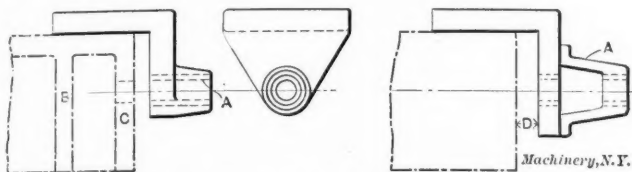


Fig. 119. A Case where the Jig is located on and supported by the Work.

The type of boring jigs described above supports the bar in two or more places, and the cutting tools are placed at certain predetermined distances from the ends of the bars, depending on the shape and size of the work. Sometimes it may prove necessary, however, to have a cutting tool inserted just at the end of the bar. Sometimes a boring jig may consist of simply one bracket as shown in Fig. 120. A very long bearing *A* is then provided so as to guide the bar true. The arrangement shown in Fig. 121 is sometimes used to insure

a long bearing for the bar. A special bracket *A* is mounted on the jig and bored out at the same time as the jig proper is machined. This provides, in effect, two bearings. In these cases bars with a cutting tool at the end are used. The reasons for using the kind of boring jig illustrated in Figs. 120 and 121 are several; in Fig. 120, for instance, there is a wall *B* immediately back of the wall *C* in which the hole is to be bored. Other obstacles may be in the way to prevent placing a bearing on each side of the hole to be finished. Instead of having a space *D* between the jig and the work as shown in Fig. 121, the jig can many times be brought up close to the work and clamped to it from the bushing side. A combination between this latter type of jig with but one bearing for the bar, and the type previously described with two bearings, is shown in Fig. 122.

Each of the different holes in boring jigs has, of course, its own outfit of boring-bars, reamers, and facing tools. In making the jig it must be considered whether it will be



Figs. 120 and 121. Examples of Guiding Arrangements where no Support is obtainable on One Side of Hole to be bored.

used continuously and what degree of accuracy will be required. When extreme accuracy is required there should be a bar provided with cutting tools for each operation to be performed. It is cheaper, of course, to use the same bar as far as possible for different operations and, ordinarily, satisfactory results are obtained in this way. It is desirable to have bushings fitting each bar, but often this expense can be reduced by using the same bushing for bars having the same diameter.

It sometimes happens that one or more holes form an angle with the axis of other holes in the work to be bored. In the

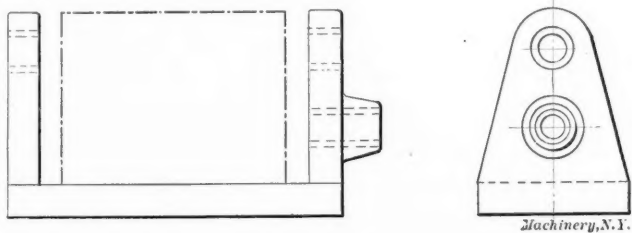


Fig. 122. Boring Jig in which One Bar has Single and One Double Bearing.

jig shown in Fig. 123 the bushings *A* guide one bar for boring one hole and the bushings *B* the bar for boring another hole, the axis of which is at an angle with the axis of the first hole in the horizontal plane. Then an angle plate *C* can be made in such a manner that if the jig is placed with the tapered side of plate *C* against a parallel, the hole *B* will be parallel with the spindle. This arrangement may not be necessary when universal joints are used between the spindle and the bar. If a hole is out of line in the vertical plane, a similar arrangement as that used for drill jigs, and previously described in this series, can be used.

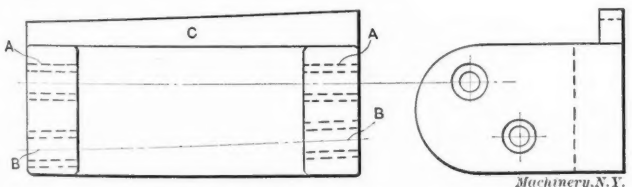


Fig. 123. Boring Jig for Boring Holes placed at an Angle to each other.

As a rule but one hole is bored out at a time owing to the fact that machines for boring generally have but one spindle. Several holes, however, could be bored out in a large size multiple spindle drill, in which case the jigs naturally ought to be designed somewhat stronger. Another method of designing jigs for boring two or more holes at the same time is illustrated in Fig. 124, the outlines only being shown in this

illustration. *A* is the gear box containing the main driving gear which is mounted on a shaft *B* which in turn is driven by the spindle of the machine. The gear on shaft *B* drives the gears and shafts connected with the boring-bars passing through the bushings *C*, *D*, *E*, *F*, *G*, and *H*. The gears are proportioned according to the speed required for each bar, which in turn is determined by sizes of the holes. The hous-

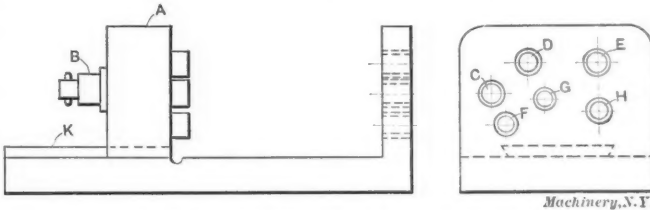


Fig. 124. Principle of Multiple Bar Boring Jig.

ing or gear box *A* slides on a dove-tail slide *K*. A particularly good fit is provided, and the gear box can be fed along in relation to the work either by table or spindle feed. If boring operations are to be performed in two directions, a jig on the lines indicated in Fig. 125 is designed. This jig may be mounted on a special revolving table permitting the work and the jig to be turned and indexed so as to save resetting

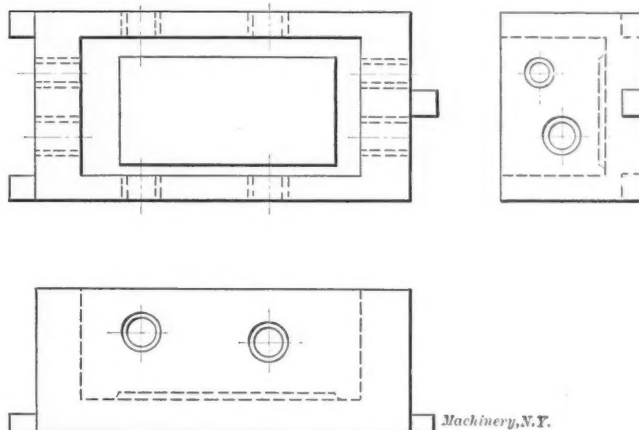


Fig. 125. Jig for Boring Holes through Work both from Sides and Ends.

and readjusting the work and jig when once placed in position on the machine.

The outline given above of boring jigs illustrates only the fundamental principles involved, it being considered more important to state the fundamental principles in this connection than to describe complicated designs of tools in which the application of such principles may be more or less obscure or hidden.

\* \* \*

Messrs. Alfred Herbert, Ltd., of Coventry, England, give the following figures for general cutting speeds, to be used on milling machines: for taking roughing cuts on cast iron with ordinary carbon steel cutters, 40 feet per minute; for machine steel, 60 feet per minute; for tool steel, 24 feet per minute; and for brass, 75 feet per minute. Finishing cuts may be taken at speeds of from 50 to 55 feet for cast iron, 75 to 80 feet for machine steel, 30 to 35 feet for tool steel, and 95 to 100 feet for brass. These figures, however, should not be taken as representing the maximum rates of cutting speed which can be successfully used even with ordinary cutters, and with high-speed steel cutters it is possible to increase the cutting speed in some cases three times that used when working with carbon steel cutters.

\* \* \*

A mix-up appeared in the note in the November issue on the use of gas engine exhaust for heating. The values should have been 11 to 15 pounds of steam evaporated per horsepower hour, from and at 212 degrees F., and 60 to 82 pounds of water raised from 32 degrees F. to the boiling point, instead of the figures given. They are approximately ten times too small in one case and ten times too great in the other. Obviously the thermal efficiency of the gas engine is figured low in order to obtain the evaporative and heating results indicated above.

## GERMAN DESIGNS OF INTERNAL GRINDING MACHINES.\*

OSKAR KYLIN.†

The possibility of obtaining accuracy and high finish on machine parts by means of grinding has been the fundamental cause of the rapid development of grinding machines in recent years. Of late, grinding machines have also been designed which have been intended particularly for removing the greatest quantity of metal in the shortest time, the question of accuracy here being secondary. These latter designs, however, are exceptions. The many special operations to which grinding adapts itself has also caused the design of a great number of grinding machines intended for special purposes. A number of these latter machines have been brought out by the firm of Mayer & Schmidt, Offenbach, a.m., Ger-

machine tools and all machining is done there. The shop is lighted in an excellent manner, due in a large measure to the saw-tooth roof construction, and in general is typical of a modern German machine shop.

One of the most interesting of the products of the firm is the type of internal grinding machine, of which various sizes are shown in Figs. 1, 2, and 3. It is more than likely that the automobile industry is largely responsible for the development of this machine, as in this industry the demand for a simple and accurate means of finishing the cylinders is imperative. The writer has seen this machine employed in most of the leading Italian automobile factories. Larger sizes of this type of machine are also built for finishing the cylinders for steam and gas engines. The first impression on examining the illustrations of this machine, is that of great rigidity throughout the design. The grinding head is

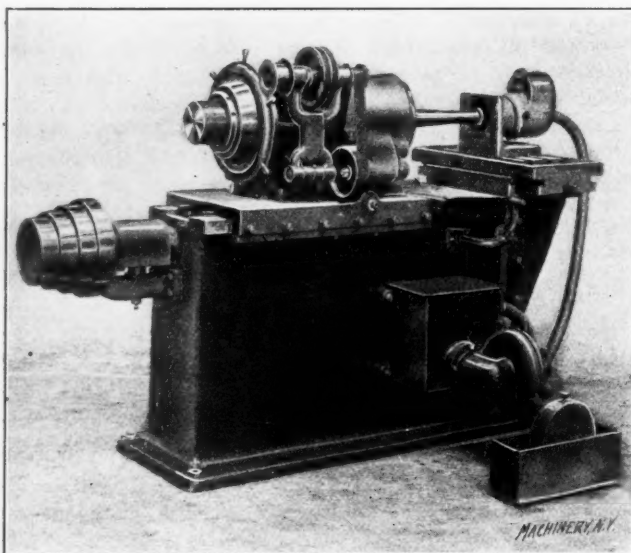


Fig. 1. Rear View of Small Size Internal Grinding Machine, showing Dust Exhausting Arrangement.

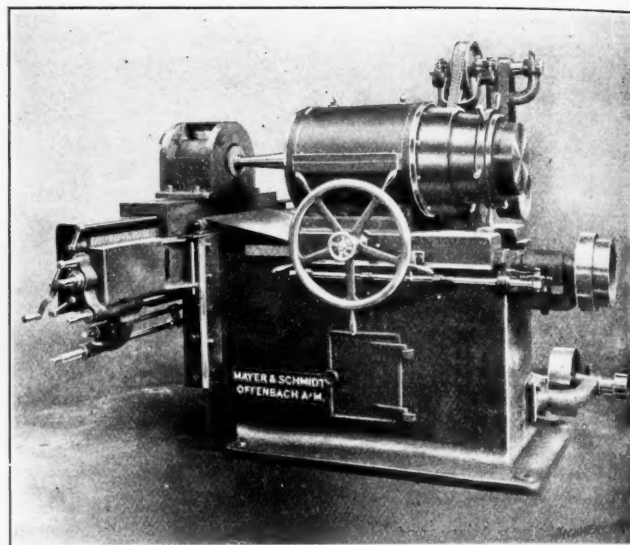


Fig. 2. Front View of another Type of Internal Grinding Machine.

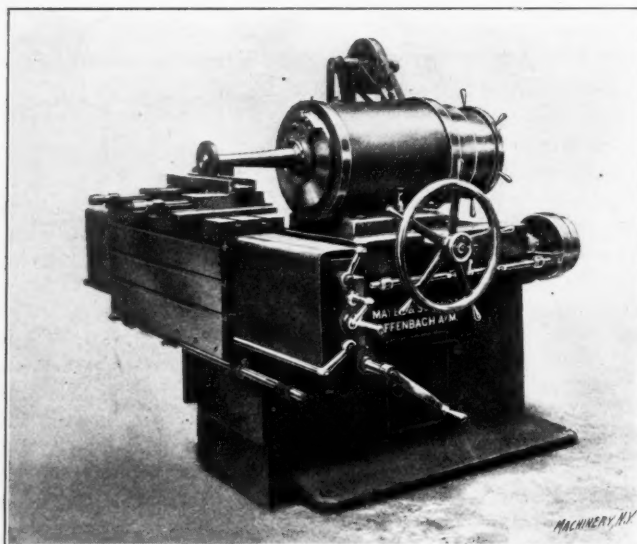


Fig. 3. Internal Grinding Machine with Planetary Motion Locked, used for Surface Grinding.

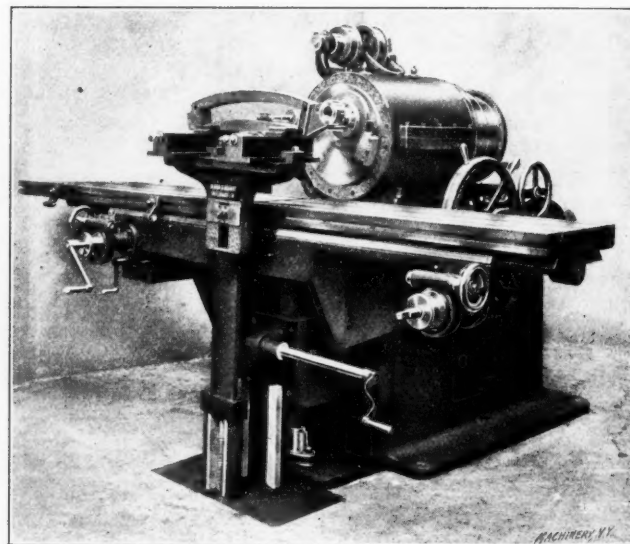


Fig. 4. Grinding Links for the Reversing Mechanism of Locomotives.

many, and a few of these are illustrated below. This firm is specializing along the lines of grinding machines, and besides the building of these, there is a large department devoted to the making of emery and carborundum wheels, emery cloth, and kindred products.

The firm's machine shop is divided up into two separate departments, one of which is exclusively working on special grinding machines, while in the other only universal grinders are made. The middle bay of the latter department, showing the space devoted to the assembling, is shown in Fig. 5. The side bays in this building are occupied by

mounted on a slide provided with longitudinal feed motion. The slide on which it is mounted rests directly on the bed, the sliding surfaces being, according to the common German practice, made flat instead of V-shaped, as is more common in America. The grinding head is fed forth and back automatically by means of a pulley which, in turn, drives a screw in the center between the two sliding surfaces or ways. An automatic reversing mechanism is provided, as shown in Fig. 2, where the reversing rod is plainly indicated on the side of the machine; faster or slower feeds are provided for by the cone pulley.

The most interesting feature of the machine is the eccentric or planetary motion of the grinding spindle and wheel. The spindle, in addition to its rotary motion, has also a motion around the axis of the grinding head, the grinding

\* See also the following articles on internal cylinder grinders, previously published in *MACHINERY*: Internal Grinding Machines, February, 1903, engineering edition; Automatic Cylinder Grinder, January, 1908.

† Address: Asklanda, Sweden.

spindle being eccentric in relation to this axis. In other words, the center line of the wheel spindle moves in a circle about the center of the head itself, at the same time as the spindle rotates about its own axis. This motion around the axis of the head is, of course, very much slower and entirely independent of the rotation of the spindle around its own center. The radius of the eccentric motion can be adjusted by hand or automatically, as required. In connection with the mechanism for adjusting the eccentricity of the spindle, a device is provided having a scale by means of which the machine can be set to grind a certain predetermined diameter of cylinder. When the diameter of the cylinder, according to this setting, is reached, the feed will stop automatically, the grinding spindle will recede from the work, and a bell will ring in order to attract the attention of the operator.

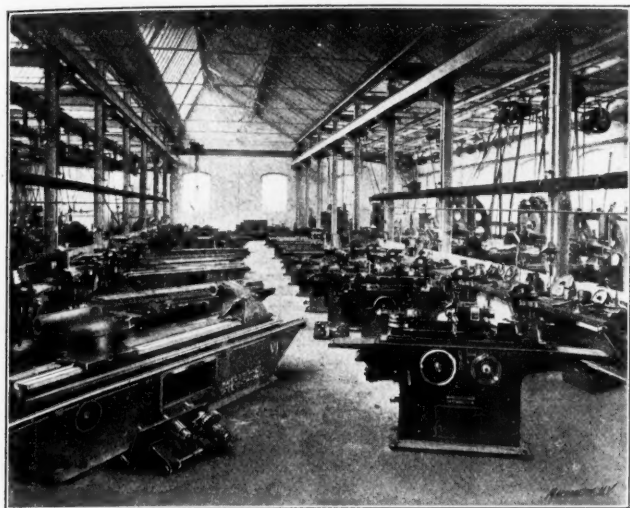


Fig. 5. Interior of One of the Shops of Mayer & Schmidt, Offenbach, a.M., Germany.

As is shown in Fig. 1, the grinding spindle is driven through a movable counter-shaft, which follows the eccentric motion of the spindle. The cylinder or work to be ground internally remains stationary during the grinding operation. As plainly indicated in the illustrations, the work is mounted on a slide having a transverse as well as a longitudinal adjustment, this being provided in order to facilitate the exact setting of the work. In Fig. 3 this type of machine is shown arranged for surface grinding of small pieces, the planetary action of the wheel spindle then being locked and out of operation.

A well devised arrangement for removing the dust and grindings, from the cylinder is shown in Fig. 1. The apparatus consists of a rotary fan which exhausts the dust through a flexible pipe from the cylinder, and delivers it into a box where the dust is collected. This feature is of great importance, on account of the means it affords for preserving the general purity of the atmosphere throughout the shop, and, as a consequence, the health of the operators.

A machine designed for the grinding of the links for the reversing gear of locomotives, is illustrated in Fig. 4. Of course, it can also be employed on a great variety of work of similar character. The general design of the machine is somewhat similar to the type of internal grinding machine already described. The work holder is adjustable transversely and horizontally, the same as in the internal grinding machine, and the work is clamped by means of two vises with parallel jaws. A swinging motion is imparted to the work holder, the radius to which the link is ground being adjustable at will.

\* \* \*

The centrifugal pumps installed in the 39th Street pumping station, Chicago, have handled a volume of water in one day that a few years ago would have seemed quite impossible for any practical outfit of pumping machinery to cope with. This station pumped 2,000,000,000 gallons of water and sewage in twenty-four hours, a quantity sufficient to flood a square mile to a depth of nine feet! The total capacity of the pumping stations in Chicago handling sewage and sewage water is about 3,000,000,000 gallons daily.

## THE ADVENTURES OF A WATER-COOLED BORING MILL.

"Say Mr. Brown," said Foreman Higginbotham to the superintendent, "wouldn't it be a good idea to put a reservoir, pump and some piping onto that boring mill over there that we keep busy on cast steel gear blanks? Water cooling works well in cutting steel in the lathe, and it seems as though it ought to help us to get more work out of the boring mill."

"Good idea!" said the superintendent. "Funny we never thought of it before. Don't know as I ever saw a boring mill rigged up for water cooling. Go ahead and try it."

So Foreman Higginbotham cut out a strip of sheet iron of the proper length, which he screwed into place around the table with a packing strip under it to keep it from leaking; then he brazed the ends together to make a tight joint. He thus had a rim on the table that would keep the water from running off the edge instead of down through the hole in the center. The next thing he did was to make a pan, which he placed in the base of the machine under the spindle, where it would catch the chips and water as they ran down through the central hole. Then he attached a B. & S. pump to the side of the frame, and connected up the proper piping and valves, and a flexible tubing connection leading to the point of the tool. After belting the pump to the counter-shaft, everything was ready for a trial trip.

Brown and Higginbotham were both present at the opening ceremonies. The operator was told to use the regular feed, but to speed the table up a couple of notches higher. The machine was started, the stream turned onto the point of the tool, and the feed thrown in. Brown, Higginbotham and the operator leaned over the table to watch results. The results came. The table was revolving rapidly, and as soon as the water struck it, it hurried for the outside diameter at top speed; where it banked up against the retaining rim. As it accumulated there, standing at an angle of 45 degrees or so, in less than no time it had reached the upper edge of



Fig. 1. The Boring Mill plays a Practical Joke.

the rim and was running over in a wet, swirling sheet which struck the three spectators amidships, marking a distinct water line on their outer garments. Of course! What else could be expected? They compromised on letting the water drizzle onto the tool at such a rate that it would bank up almost to the top of the rim at the completion of each operation, when the stopping of the table let it run back through the center hole into the pan prepared to receive it.

Shortly after this compromise, an editor (who, unlike friends Brown and Higginbotham, shall be nameless) appeared on the scene. The editor was a man of ideas. He had just stepped off a train on a trunk line railroad, where the stops were too far apart and the schedule too fast to permit the locomotive to line up opposite the water tank for a drink every time it needed one. Instead, the fireman dropped his scoop into a

trough between the tracks and filled the tender on the run. With this idea in his mind, the brilliant editor suggested the plan of making a scoop for the boring mill, dipping it into the banked up water inside the table rim, then draining it, through a rubber tube, into the reservoir. No sooner said than done. The scoop was made and at the proper angle set. The editor, Higginbotham, Brown, and the operator gathered around the machine for a second trial. The water accumulated as before, but the scoop picked it up and delivered it to the reservoir in a very satisfactory and fascinating way. As the operation proceeded, however, the chips also began to accumulate close to the rim, and before long these had banked high enough to strike the scoop. Zip! Its front lip was bent backwards. Zip! It struck the chuck jaw and was sent out through the window, and the fountain display which had been a feature of the first performance, was again repeated. Having important business on hand, the editor was forced at this stage of the proceedings to catch a train for a distant city, so his clients were deprived of his valuable advice at this juncture.

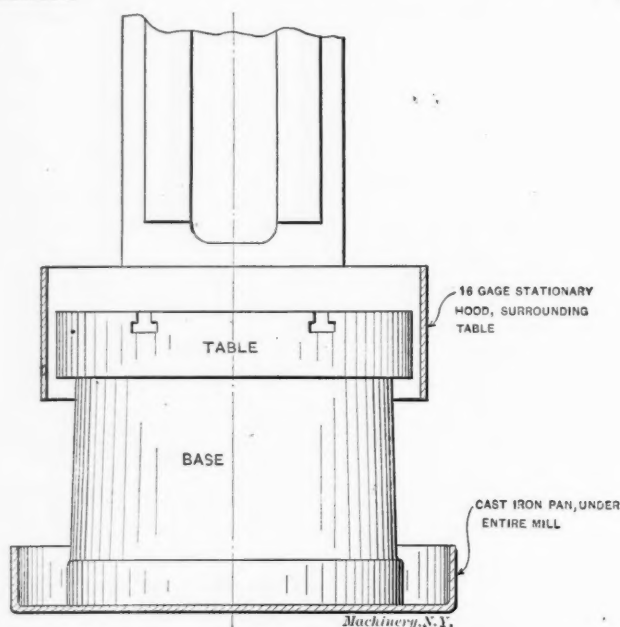


Fig. 2. The Guard which did the Work.

A few days ago the editor got a letter relating to the doings of the only man concerned who had as yet offered no suggestions. It was now the operator's turn. This gentleman, after profound thought, had removed the rim from the table and replaced it with a stationary guard (as shown in Fig. 2), which entirely surrounded the table, and served simply as a splasher to stop the course of the water, as it was thrown off by the revolving table. After striking this guard, the water dropped down into the pan in which the boring mill was set; from here it was drawn by the pump and forced back onto the tool again, none of it flying beyond the confines of the machine, even when the tool was flooded.

By the way, why should not the tool be flooded when cutting steel in the boring mill as well as in the lathe, and is there any simpler or more effective way of controlling the water than the scheme last described?

\* \* \*

The German government is employing very commendable methods for increasing its foreign trade and for gaining knowledge of foreign trade conditions. Instead of making its consular service largely a department through which payment is made for loyal service during political campaigns, the German government endeavors to place only men known as commercial and technical experts at important German consular posts. The work of these officials has been of great benefit to German industries. The important work done by special agents sent out by our government could in a large measure be done by the consuls if men of commercial and technical ability and insight were appointed to these offices. In this respect it would be beneficial to our industries if our administration followed the example of Germany.

## DON'TS FOR INVENTORS.

H. S. BUSEY.

Don't wait for inspirations. The faculties for inventing must be trained by careful study and diligent research.

Don't allow difficulties to discourage you. Persistent effort seldom fails to overcome them.

Don't overlook the little things, but practice the "art of taking pains."

Don't be satisfied with your invention until you have learned every thing possible relating to previous efforts and achievements in that particular line.

Don't submit your invention for a patent until you have made all possible improvements. If this requires much time get a caveat.

Don't send sketches or drawings to the patent attorneys without your signature and date on every sheet. Have a witness to sign them also. The attorneys file these sketches, which can be used to advantage in proving priority of invention.

Don't talk about your invention to every one you meet, but without going into details, get the opinion of one or more trusted friends.

Don't demonstrate your invention in public until you have applied for a patent, or better, have been granted one.

Don't exhibit any but a neat working model of your invention in public, and make sure it will work perfectly.

Don't exaggerate the advantages of your invention; hold your enthusiasm in check, while explaining its merits to anyone.

Don't show disappointment if your invention is not immediately appreciated; persistent and untiring effort on your part will bring reward if the invention has real merit.

Don't make any agreement or assignment without consulting a reliable lawyer. It pays to have them written in a legal manner.

Don't employ any but the best patent attorney to write up the specifications and claims of your patent, otherwise it may prove to be worthless.

Don't employ any patent attorney not registered by the Patent Office.

Don't fail to get a Canadian patent if your invention is patented in the United States.

Don't wait too long before applying for foreign patents. Get as many as can be profitably worked with your particular invention. Patents in Great Britain, Germany, and France are specially desirable.

Don't assign even a small part interest in your invention; if necessary, assign a certain portion of the net profits derived therefrom. The holder of an undivided interest in your patent can, if he choose, use the same to your disadvantage.

Don't forget that many inventors have practically lost their patents by assigning undivided part interests, or by signing agreements that they did not fully comprehend. Don't be hasty in such matters, but go over every point carefully, and consult a trusted lawyer before signing or taking any action whatever.

Don't overestimate the value of your patent or invention. Remember that the value of an invention cannot be foretold and that much depends on the way it is managed in placing it upon the market.

Don't, when offered a cash price, refuse to take it, if the sum be sufficient to cover your expenses and leave a reasonable reward for your efforts. The purchaser relieves you of all further responsibility and is taking chances on making it a commercial success.

Don't overlook the fact that shop-rights and territorial rights are sometimes more profitable than selling the patent outright.

Don't try to promote a company of your own to market your invention unless you are experienced in such proceedings, and have assurance and plenty of capital to carry on the business.

Don't assign your patent rights to an incorporated company without having positive knowledge of its financial standing, and the ability of its management. Otherwise, should the company fail, or go into the hands of receivers, the patent rights will be sold to the highest bidder.

## ITEMS OF MECHANICAL INTEREST.

## ICE TUMBLERS.

Drinking tumblers made entirely of ice are a novelty which has recently been introduced in Europe by the Nederlandsche Ysbeker Maatschappij (Procédé Huizer), Hague, Netherlands. One of these tumblers inserted in a paper shell for convenience

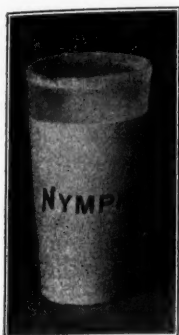


Fig. 1. Ice Tumbler.

in handling, is shown in Fig. 1, while Figs. 2 and 3 illustrate the mold in which it is formed and frozen. If desired, the tumbler can be made with varying degrees of transparency, or even colored by the addition of some harmless coloring matter, and, as it is only used once, it is ideal from the hygienic point of view.

Fig. 3 shows a sectional view of the mold in which the tumbler is frozen. A measured quantity of water is first poured in the mold *a*, and then the core *c* is inserted, which forces the water upwards in the space between the two. The mold is then placed in the brine *m* through an aperture in cover plate *l*. The freezing soon begins, because of the thin layer of water exposed, and the tumbler is ready for use in from 6 to 15 minutes, with brine temperatures of



Fig. 2. Mold in which the Tumbler is Frozen.

14 and -4 degrees F., respectively. In order to facilitate the removal of the frozen tumbler, the mold is made of a material expanding more rapidly than ice, and the core of a material expanding slower than ice. By sinking the apparatus into a special heater giving off just enough heat to expand the mold without injuring the tumbler, the latter is withdrawn from the mold, but still clings to the porcelain core, principally by the raised ring of ice bearing against it at the bottom; this pressure is due to the different coefficients of expansion of the ice and the porcelain, the latter being smaller. By pushing the piston *d*, which is connected with the handle *g* by the rod *f*, downward, the tumbler is removed from the core and caught in the paper shell which prevents it from coming into direct contact with the hand. The tumbler is then ready for use.

It is estimated that about one hundred of these ice tumblers can be made in one hour, with the expenditure in energy of one horse-power, and at a cost per tumbler, encased in a paper shell, of one-half a cent each. A small refrigerating machine will produce these tumblers in considerable quantities, and after being made they can be stored, until ready for use, in refrigerators.

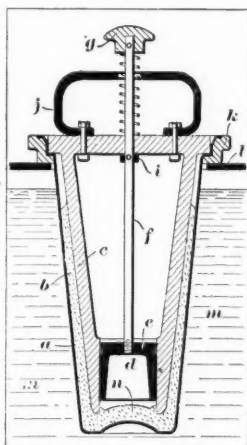
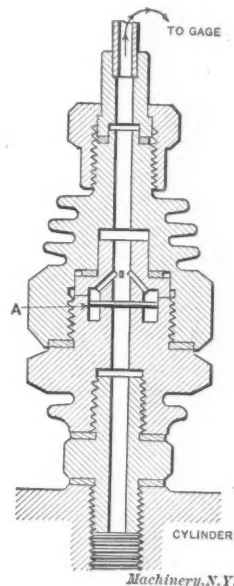


Fig. 3. Sectional View of the Mold.

## PRESSURE INDICATOR FOR INTERNAL COMBUSTION ENGINES.

It is a rather difficult matter to take satisfactory indicator diagrams for high speed internal combustion engines, and it is particularly difficult to determine from the diagrams exactly the amount of compression and the maximum pressure developed, as well as the degree of vacuum during the suction stroke. These quantities, however, can be ascertained by a simple pressure indicator, which has been introduced by Messrs. Negretti & Zambra, 28 Holborn Viaduct, E. C., London, and described in the October 30, 1908, issue of *Engineering*. This instrument is of French origin, and has been named the "acrometer." It consists essentially of a light non-return valve, interpolated in a pipe connecting the cylinder with an ordinary pressure gage, this valve with its connections being shown in the accompanying line engraving. Gases from the cylinder can flow through this valve into the gage, but cannot return, so that when the gage is put into communication with the engine cylinder the pointer of the gage will almost instantly indicate the maximum pressure in the cylinder and continue to do so even if the latter be followed by more or less throttling of the gas supply. If more gas is admitted, a higher maximum pressure will be recorded. If, on the other hand, the gas supply is throttled, thus reducing the maximum pressure, the continual loss of heat through radiation from the gage and connecting pipe, soon causes the pressure indicated by the gage to fall to that developed in the cylinder. This fall of pressure in the gage to correspond to the pressure in the cylinder is hastened by the fact that the joints above the non-return valve are not made absolutely gas-tight. To obtain the compression pressure, a few successively missed ignitions are arranged for. The pressure already indicated in the gage is then released by a valve, and when it is again closed the gage will indicate the degree of compression. In the accompanying engraving the non-return valve itself is shown at *A*, and consists simply of a disk of a platinum alloy, access to which can be gained by unscrewing the cap above it. The lower part of the instrument which screws into the cylinder is made from chrome steel, so as to better resist the action of the hot gases from the cylinder. It is stated that the device in question is used considerably in France.



Section of Valve used in Conjunction with Gage for Recording Gas Engine Pressures.

\* \* \*

A few years ago (November, 1905) a note appeared in these columns relative to the limitation of the speed of the sewing machine because of the heating of the needle due to friction in the cloth. With ordinary thin fabrics the limit is about 3,000 to 3,500 stitches per minute, but if two or three double folds of the same material are sewed, the working speed must be reduced to say 2,500 stitches per minute, as otherwise an ordinary sewing machine needle will become so hot that it will turn blue and lose its temper. Curiously, it has been found that nickel plating sewing machine needles materially increases their working speed. The latest improvement is a peculiar alloy substantially the same as high-speed steel. The fact that the limitation of sewing speed is the endurance of the needle, makes the improvement of direct bearing upon the cost of clothing, and it is an excellent illustration of the far-reaching effects of the discovery of high-speed steel. On lock-stitch machines the limit of speed now is the ability of the mechanism to stand the tremendous strain on its reciprocating parts; no matter if the needle does become blue with heat, its temper is not affected, but on the contrary, it is even harder when hot than cold. In this case the line of future improvement is in the direction of improving the machine rather than the tool or needle.

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# MACHINERY

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DESIGN—CONSTRUCTION—OPERATION.

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## AN INDUSTRIAL DEMOCRACY.

The opinion that Germany will be America's chief competitor in the manufacture of machine tools in the future has been voiced by every one who, of late, has studied industrial conditions in Germany; and the subject was brought prominently before American machine tool builders at their recent convention by Captain G. L. Carden.

Without question, Germany has recently developed an extraordinary industrial efficiency; and it is interesting to examine the different causes which have placed that country and America in leading positions in the industrial field. In America, one of the fundamental causes of development in the machinery industry has been the free scope given to individual initiative, and the possibility thereby afforded for utilizing the intelligence of the workman on the problems connected with his work. In Germany, encouragement for the individual, so common with the rank and file in America, has been generally lacking; but this lack has been made up, to some extent, by the more thorough training of the few who occupy supervisory positions. In a sense, the Germans have built up an industrial aristocracy, while in America the development has been along the lines of an industrial democracy.

Captain Carden, in his address, called attention to the beneficial effect, industrially, of the military training imparted in the German army service; and this is true in so far as it is desirable to build up an industrial community which follows, more or less blindly, a few appointed leaders, but in which the individual initiative, so important a factor in the development of American industries, is almost entirely lacking. Military training, as practiced in Europe, is the most effective means of suppressing individuality, its first principle being to teach the masses to obey. In most European countries the ambition of the worker is dulled by the knowledge that he is expected to fill his place as a mere machine; and while he may attain high efficiency in his work, he is not encouraged to independent activity.

The German system represents thorough technical training, experiments intelligently planned and carefully carried

out, and scientific principles applied to machine design. These have been the most important factors in the recent development of the German machine tool industry. The American system, as previously stated, is exemplified by the possibilities for individual initiative, the incentives to ambition, and the prizes for originality and development offered the masses. A combination of American and German methods and forces, working harmoniously together, should therefore produce the ideal industrial democracy.

\* \* \*

## MOVING PICTURES AN AID TO TEACHING TRADES.

The present day conditions in manufacturing, which so seriously affect the education of young men in useful trades, are attracting wide-spread interest among educators, manufacturers, workmen, capitalists, and practically all who realize the difficulty of acquiring the skill and knowledge essential to any workman who aspires to be a master of his trade. The principle of manufacturing, as now conducted, is essentially antagonistic to the education of skilled workmen, except as specialists; but a condition which results in too many specialists, and too few master workmen is detrimental to the trade.

There are many plans for the education of industrial workers, but none complete or entirely satisfactory, although all may have some very good features. The chief fault of most plans of industrial training is that the learner is removed from the commercial shop atmosphere if he receives the individual instruction desirable. If trained in the shop, he receives little individual instruction, the learner's interests being sacrificed because of the commercial necessity of promoting production.

The moving picture machine offers a partial solution of the problem of imparting individual instruction in the trades. Next to actually doing the thing or seeing a skilled workman do it, is the seeing of it done in a series of moving pictures. For example, take the operation of accurately filing a flat surface on a piece of cast iron held in a vise: A series of pictures showing the correct position and manner of handling the file, could not help making a strong impression on earnest learners of the machinist's trade. The same method would apply to the operation of chipping with the hammer and chisel, scraping, lapping, laying out, and many other hand operations almost impossible of complete description without working examples.

In machine work, the moving picture scheme could be employed with even greater success. The operation of chucking a casting on the face-plate of a lathe and boring and facing, could be shown vividly. Dozens of other operations shown in this way could be repeated indefinitely for the instruction of countless numbers of young men. They would be impressed by the methods illustrated and the spirit in which a skilled workman proceeds in doing the things portrayed. The first investment for films illustrating shop operations would be very heavy, and the plan must be worked out cooperatively in order that manufacturers may avail themselves of this system of imparting apprenticeship instruction cheaply. In our opinion there is merit in this idea as one feature of a general scheme of industrial education.

\* \* \*

Automobile racing is of doubtful value as regards the proper development of the automobile. Under conditions governing past events, the manufacturer was free to build the automobile of practically unlimited power, consequently the speed of an automobile, that could be obtained in racing, was limited only by the purse of the manufacturer and the physical limitations that must be met in the designing of a road machine. Hereafter, however, entries for the Vanderbilt cup races must conform in cylinder diameter to the following maximum dimensions: The bore of cylinder will in future be restricted to 130 millimeters and the stroke to 130 millimeters. With this limitation of cylinder diameter and stroke, the manufacturer who hopes to succeed in future racing contests must design his engine and transmission for the highest possible efficiency, and thus some good may result because of the enforced superior mechanical design.

## MANUFACTURERS VS. MONOPOLISTS.

FRED J. MILLER.\*

What appears to us to be one of the most unpleasant incidents of the political campaign, happily now ended, is the revelation of the fact that the *Manufacturers' Record*, of Baltimore, has received at least one of the now famous "certificates of deposit" from John D. Archbold of the Standard Oil Company. Though we have endeavored to do so, we have found in the columns of our contemporary nothing like an adequate or satisfactory explanation. It publishes a letter received from John Skelton Williams in which Mr. Williams says "They (the Standard Oil Company) had a legitimate motive for wanting to promulgate sound views regarding the products and advantages of this (the South) section." Mr. Williams tries to make it appear that the certificate of deposit was a payment made for extra copies of the paper, or for other documents issued from the publishers' office and in which the "sound views" referred to are "promulgated." The fact that this payment of \$3,000, like those made to certain prominent and hitherto more or less influential public men, by Archbold, was in the form of a certificate of deposit instead of a check, indicates clearly enough that the payer, or the recipient, or both, had reasons for not wishing it to be known to others that the \$3,000 had been paid. What may we fairly suppose these reasons to be? In view of the record of the Standard Oil Company, can we suppose them to be legitimate business reasons?

The *Manufacturers' Record* vigorously defends child labor as practiced in the Southern cotton mills. Is this because it has received a certificate of deposit from some one whose interests lie in that direction, or does it really and sincerely believe that this abomination, condemned by practically all disinterested sociologists, is actually a good thing for the South?

The ultimate best interests of manufacturers, North or South, can be served by no paper which is not free to express its honest convictions, or whose circulation is not based upon entirely legitimate subscriptions received from those who buy the paper because they want to read it.

A manufacturer is one thing; a monopolist is another. Sometimes the two are combined in one individual or organization; but the Standard Oil Company, though it is a manufacturer, is preeminent as a monopolist. Manufacturers, as such, do not scatter certificates of deposit among members of Congress or in newspaper offices, and those who receive such certificates from representatives of monopolies do not in return for them, give much consideration to the interests or rights of manufacturers.

The interests of manufacturers and of monopolists are usually directly opposed, and one of the most serious mistakes being made at the present time is in the failure to more generally recognize that fact. No writing upon any wall was ever more plain than is now the fact that monopolies of all kinds are to be much abated or abolished. The faces of the people in practically every country are set in that direction. It cannot be too much insisted upon that a manufacturing enterprise, though it may be large and prosperous and even incorporated, is not necessarily a monopoly; it may on the contrary be honest and beneficent, and usually is so when conducted in the face of actual or potential competition.

There is too much of confusing manufacturers with monopolists, and perhaps the most discouraging feature of the situation is that this confusion exists in the minds of many manufacturers who are by no means monopolists and whose interests are opposed to monopoly.

Such misapprehension and confusion will, we fear, be somewhat increased by the wide publication of the fact that a Standard Oil "certificate of deposit" for \$3,000 has been received by a journal which by its title and for other superficial reasons, may be supposed to especially represent manufacturers and to stand for their interests.

[The above editorial, written by Mr. Fred J. Miller, fits in with an idea we have had in mind for some time, to invite short editorials from practical men, published over their own signature, on subjects of current interest. In publishing them MACHINERY assumes no responsibility for the opinions expressed. The editors reserve the right to reject articles which may not reflect ideas of sufficient importance to warrant publication.—EDITOR.]

\*P. O. Box 27, Center Bridge, Pa.

## WHY IS THE BLACKSMITH SHOP NEGLECTED?

In any thorough comparison made between the conditions under which the average machinist and blacksmith work in most of our industrial plants, the blacksmith shop usually suffers. This department is commonly housed in one of the darkest and most dismal of the shop buildings, provided with no other heat than the radiation from the forges, with no ventilation, sanitary appliances or wash rooms, and with an equipment which compares very poorly with that used in the machine shop. It is difficult to account for this difference in surroundings and conditions, because there is no valid reason why the blacksmith should not have as good light or as much comfort as the machinist. The existence of these conditions, however, indicates that the blacksmith and his work are not considered as important an adjunct to the machinery industry as the machinist and his work, and therefore may be treated with less consideration. This view, if it is held by those in responsible positions, is unsound, and shows that most men in authority over such enterprises have received no early training in the blacksmith shop, and have therefore been brought up to consider it as an adjunct of small importance to the department in which they were trained. These men are naturally slow to change their ideas in later years, and consequently the belief that "any old thing" is good enough for the blacksmith shop, has in many cases become the prevailing one. Such a condition is deplorable, because the blacksmith and his work are important enough to deserve the same consideration as the men and the work in other departments. The possibilities of blacksmithing are far greater than most mechanics appreciate; and if the blacksmith be given proper tools and equipment, and the blacksmith shop itself proper attention, a large amount of machining and expensive work done in the machine shop could be largely eliminated by forging to shape; but if the blacksmith shop is neglected, it is not likely that men who can originate new ideas will be attracted to the trade, and this will undoubtedly result in a loss to the machinery industry as a whole. Efficient men are needed in all departments—in the blacksmith shop fully as much as in other departments, in order to develop it properly and in harmony with the rest of the business.

There is no reason why the blacksmith should be subjected to more physical discomfort than other workers in the shop, and it has been demonstrated in many cases that the outlay to provide comfortable surroundings for industrial workers yields ample returns in increased efficiency. Physical discomfort and mental capacity are seldom found together; and the development of the blacksmith shop has not kept pace with the remainder of the establishment simply because mere physical strength has been considered the chief requisite in a blacksmith, and mental ability of less importance. This conclusion needs modification if the full possibilities of the blacksmith shop are to be realized.

\* \* \*

As every technical graduate has discovered, there are many factors entering into the design of machinery which cannot be calculated by mathematical processes or determined from standard tables. One of the commonest and most important of these factors is the commercial one, which deals with the tastes and prejudices of the purchaser, and the possibility of persuading him to exchange good money for a good machine. The instinct for commercially correct design is one of the most difficult, and at the same time one of the most valuable qualifications that an engineer can acquire.

A very striking example of one of these incalculable commercial factors came to our notice the other day in connection with a certain special machine tool, which was being built for a customer located in a region where the trade unions are particularly active. One of the rules of the union to which the prospective operators of this machine belong, is that no member shall operate two machines. As a consequence of this rule, and of the desire of the manufacturer to increase his output and his profits, the simple expedient was evolved of building two machines on one base. The design was preposterous from any imaginable mechanical view-point, but from the purchaser's position the logic of the construction was very clear. The machine has been in use some time, and appears to satisfy both the workmen and the employer.

## ENGINEERING REVIEW.

### CURRENT MECHANICAL EVENTS—LEADING ARTICLES OF THE TECHNICAL PRESS.

One of the French railroads has ordered special railway cars for transportation of automobiles. These cars are provided with stalls and appliances for securing the automobiles in the cars so as to safeguard against injuries to the automobile while in transportation.

Count Zeppelin's new airship, the fifth one of his construction, has been completed, and at the initial flight carried ten passengers and maneuvered for three and one-half hours in the air, rising to a height of 600 feet and attaining a speed of about 30 miles.

It has often been pointed out that the limiting factor of large ocean vessels is the harbor facilities of the various ports of call. In order to accommodate the new White Star Liners, *Olympic* and *Titanic*, of which mention was made in a previous issue, negotiations have been completed for the construction at Southampton of a large dock to have a depth of 40 feet of water at low tide, so that it can accommodate these vessels at any hour of arrival.

Experiments have been undertaken by the British Admiralty at Portsmouth, England, for testing the De Forest system of wireless telephony. Communications were kept up between vessels out of the harbor, and vessels lying in the harbor, and messages were distinctly heard over a distance of more than fifty miles. Some interruptions occurred, however, owing to the use of wireless telegraphy by the ships in the neighborhood.

The first mono-rail passenger line to be installed in the United States is likely to be built within the limits of New York City on the route of the old horse-car line from the New Haven Railroad tracks to City Island. The cars will be carried on two 2-wheel trucks, the wheels running tandem on a single rail. Stability is obtained by two overhead trucks carried on arms, each truck running on L-shaped overhead rails, carried on standards. These guide rails also act as conductors for the current. It is not conclusively proved, however, that any real advantage, either as regards cheapness of construction or operation, is to be gained by this construction over the ordinary two-rail track.

The hour-glass is commonly regarded as an ancient time-piece of no practical importance to-day, and more of a historical curiosity than anything else, but the hour-glass and modifications of it still have important uses. For timing hardening and tempering heats in twist drill manufacture and for similar purposes, where the operator requires to have an accurate gage of the time elapsed in seconds or minutes, there is nothing so simple and so reliable as a sand glass, of such proportion that the sand will run out in a specified number of seconds or minutes. No calculation is required of the operator; he has no timepiece to watch but simply the running stream of sand. It has a valuable characteristic in that it enables the user to anticipate the exact moment at which the sand will run out and thus gage the time to a fraction of a second. This is very difficult to do with a watch.

The National Conservation Commission intends to take a comprehensive census of the standing timber in the United States. Several estimates have been made in the past, but, of course, the figures given are more or less unreliable. It has been assumed that there is an available stumpage of 1,400 billion feet, and that the annual use is about 100 billion feet. Assuming these figures to be correct, and neglecting growth in the calculation, it will be seen that our timber supply will be exhausted in 14 years. Assuming the same figures to be true, and also an annual growth of 40 billion feet, we would have a supply for 23 years. Some estimates of our stumpage give as high as 2,000 billion feet, which

would give us a supply for 20 years, neglecting growth, and a supply for 33 years assuming an annual growth of 40 billion feet. It is apparent from these figures that we are much nearer the exhaustion of our timber supply than most people have ever imagined.

The Westinghouse Electric & Manufacturing Company has been awarded the contract to electrify the Manhattan and Queens terminals of the Pennsylvania Railroad, the initial amount of the apparatus required under the contract amounting to \$5,000,000. The electrification of the terminals will include the long stretch of track between Newark, in New Jersey, and Jamaica, L. I. The Westinghouse Co. has already built a huge electric locomotive and this engine, operated over a special track on Long Island, has met the requirements for speed and power. A speed of 120 miles an hour has been reached in tests and the engine will develop 4,000 horse-power. A hundred of these engines, bigger and more powerful than any electric engines ever built, will be built for the Pennsylvania. The model engine has been put to severe tests for elasticity of construction, for power, speed, and action on rails and curves. A rough estimate of the amount of horse-power to be used in the electric zone, under river and land, is about 250,000 horse-power.

In a note in *Engineering*, issue of October 30, 1908, a comparative table compiled by the Swedish Patent and Registration Office is given, showing the percentage of patents in force in various European countries after a certain number of years from the issue of the patent. The patents, it appears, lapse on account of non-working, which, of course, indicates that the patent has proved to be of small or no value. The term of patents in most European countries is fifteen years, and the table shows that during the fifteenth year only six per cent of the total number of patents issued are still in force in Sweden, while in Germany and Great Britain this figure is 3.5 and 3 per cent, respectively. Italy shows the smallest percentage of patents alive for a period of fifteen years, there being only two out of every 100 patents in force for that number of years. This indicates how few inventions are really of practical value. Of the patents, those for inventions in the chemical field proved to have the greatest longevity. Next come the electrical patents, and the patents that appear to be of the smallest value in proportion to the number issued are those relating to ordinary mechanical appliances.

An interesting example of the increase in land values following an important engineering undertaking is given by *Mercator*. Referring to the Assuan Dam in Egypt, this publication states that the total cost of the dam will be \$12,000,000, but this expenditure has so far made possible the irrigation of an area of about 175,000 acres, and the increase in the land value has amounted to about \$25,000,000. During the next three years about 275,000 acres additional land will be irrigated, and the increase in the value of this will be about \$40,000,000. It is the intention later to increase the height of the dam about 25 feet, which would enable the irrigation of an additional 500,000 acres. The expense for this work would be about \$2,400,000 and the increased value of the irrigated land \$75,000,000. Something like a total expenditure of \$14,400,000 will thus be followed by a corresponding increase in land value of \$140,000,000. This is simply a single example of how all improvements of a public character tend to increase the value of land. If this increase in value were turned into the public treasury, it could be made to pay easily for all public improvements required. A similar example may be had in New York City, where the building of the subway produced an increase in the value of the land in the upper part of Manhattan Island and the Bronx largely exceeding the cost of the subway itself. If this increased value, due to public improvements, reverted into the public treasury, there would always be ample means for extending public works.

## INTERCHANGEABLE INVOLUTE GEAR TOOTH SYSTEMS.

Abstract of Paper by Mr. Ralph E. Flanders, read before the American Society of Mechanical Engineers, December, 1908 Meeting.

The purpose of this paper is to investigate and compare various interchangeable involute gear tooth systems, including the standard form. This investigation was suggested by the many departures from the standard form which have been made in recent years. These departures are becoming more and more numerous, and their increasing use on certain classes of work suggests that the standard form may be unfitted for a considerable part of the field it was intended to cover.

Briefly, the results of this investigation may be summarized as follows: First, the present standard system is involute for but a comparatively short portion of its outline—in fact, for not over 35 per cent of its total height; the shape of the remaining portion of the tooth is known only to the makers of the cutters, so that the system is a private commercial standard instead of an open public engineering standard. Second, marked improvements can be effected by adopting a new standard, in the direction of avoiding interference, giving greater length of involute contact, increasing durability, and, especially, in the matter of increasing the strength; it seems to be clearly shown that a new standard should be adopted, at least for heavy gearing.

## Scope of the Investigation.

The standard form of gear tooth for cut gearing has a pressure angle of  $14\frac{1}{2}$  degrees and an addendum (in a one diametral pitch gear) of one inch or  $1 \div P$ . The pressure

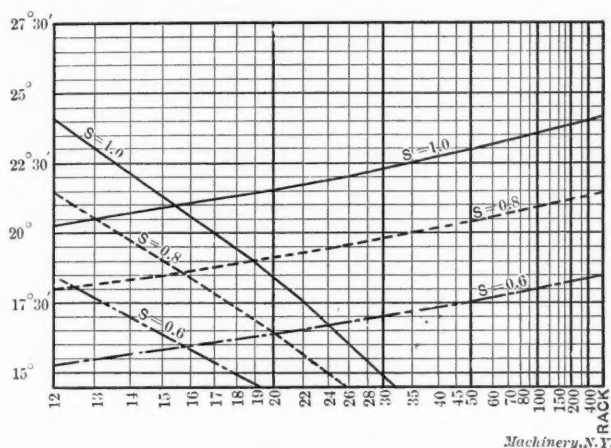


Fig. 1. Effect on Interference of Changes in Addendum and Pressure Angle.

angle of an involute gear is the angle that the line of action makes with the common tangent to the pitch circles of two gears in mesh; or it may be stated as the angle made by the side of a rack tooth of a given system, with the perpendicular to the pitch line (see  $a$  in Fig. 4). In any system of involute gearing the pressure angle remains the same for all gears in the series. The addendum is the height of the tooth above the pitch line. As this also remains the same for all the gears in a series, a system of interchangeable involute gearing may be defined by giving the pressure angle and addendum.

For the sake of simplicity, in all the calculations herein recorded, the teeth are supposed to be of one diametral pitch. The pressure angles investigated range from  $14\frac{1}{2}$  to  $27\frac{1}{2}$  degrees. Three heights of addendum are considered: 1.0, 0.8 and 0.6 inch respectively, for one diametral pitch. These limits are thought sufficient for the purposes of this paper. It should further be stated that in all calculations where it is necessary to assume the number of teeth in the smallest gear of a series, that number is taken to be 12, the same as in the standard system. The following reference letters are used:

- $S$  = height of addendum,
- $\alpha$  = pressure angle,
- $N$  = number of teeth,
- $n$  = number of teeth in continuous action.

## Effect of Varying the Pressure Angle and Addendum.

The effect of varying the addendum and pressure angle is investigated with reference to the following practical considerations: interference; number of teeth in continuous action; side pressure on journals; strength; efficiency; durability; permanence of form; quietness and smoothness of action; suitability for practical cutting processes; and miscellaneous practical considerations.

Fig. 1 illustrates the effect of changing the addendum and the pressure angle on the question of interference. The lines rising toward the right in the diagram indicate the largest number of teeth in the gear in any given system of interchangeable gearing, which will mesh with a 12-tooth pinion without correction for interference with the flanks of the teeth of the latter. Thus, in a system of interchangeable

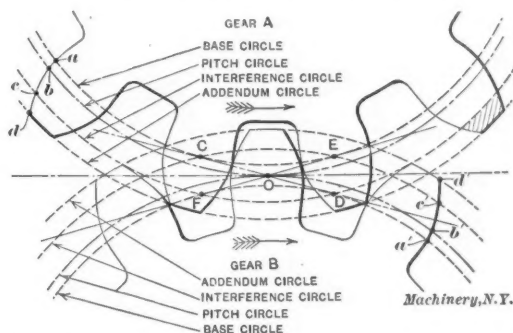


Fig. 2. Extent of Interference between Two 12-tooth Standard Pinions.

gears in which  $\alpha = 17\frac{1}{2}$  degrees and  $S = 0.6$ , the diagram shows that all gears having more than 50 teeth must be corrected to avoid this interference with the 12-tooth pinion. The lines rising toward the left indicate the minimum number of teeth possible in the smallest pinion in an interchangeable series, to avoid entirely the phenomenon of interference. Thus with the standard form in which  $\alpha = 14\frac{1}{2}$  degrees and  $S = 1.0$ , if 32 be taken as the number of teeth in the smallest gear of the series, instead of 12, it will not be necessary to correct the rack of any other member of the system for interference.

The following formulas were used in calculating this diagram. For the maximum number of teeth possible without interference with the 12-tooth pinion,

$$N = \frac{36 \sin^2 \alpha - S^2}{S - 6 \sin^2 \alpha}$$

For the minimum number of teeth possible without interference with an uncorrected rack,

$$N = \frac{2S}{\sin^2 \alpha}$$

It will be seen from the diagram that with the standard form of gearing, in which  $\alpha = 14\frac{1}{2}$  degrees and  $S = 1.0$ , in-

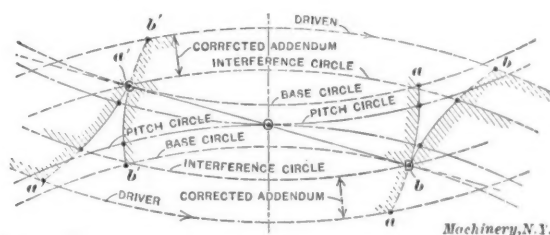


Fig. 3. Limits of True, Involute Action with Two 12-tooth Standard Pinions in Mesh.

terference occurs to such an extent that the correction of the face of the tooth has to be carried clear down to the smallest gear in the series, it being impossible for two uncorrected 12-tooth pinions to mesh without interference. This condition is shown in Fig. 2. The contact between the two gears, running in the direction indicated and with gear A as driver, takes place along the line  $CD$ , being determined by the points of tangency of this "line of action," as it is called, to the "base circles" of the two pinions. That part of the face of the teeth of gear A (see shaded portion at the right) which lies outside of the interference circle passing through point  $F$ , extends beyond any possible contact with the mating

pinion, and so is useless for conjugate action in its uncorrected form. Not only is it useless but it is positively harmful as well.

Fig. 3 shows, in diagrammatic form, the positions of the teeth of the two gears in Fig. 2 at the beginning and end of their action; contact begins at *C* and ends at *D*. As the gears continue to revolve, tooth face *aa* of gear *A* will interfere with tooth flank *bb* near the base circle, making proper meshing of the teeth impossible, no matter what the form given to the flanks of the teeth below the base circle. This phenomenon of interference is discussed in all treatises on gearing.

Everything outside the interference line then, in Fig. 2, must be corrected for interference. The amount of this correction increases with the number of teeth in the gear, reaching its maximum in the rack as shown in Fig. 4. As will be explained

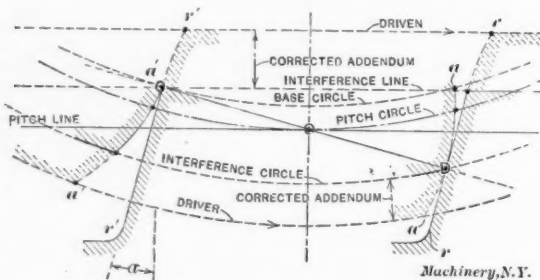


Fig. 4. Limits of True Involute Action with a 12-tooth Pinion and Rack (Standard) in Mesh.

later, the nature of the correction depends on the form arbitrarily given to the flanks of the teeth of the smallest pinion, below the base circle.

The next thing to consider is the number of teeth in continuous action. Fig. 5 shows the maximum and minimum number of teeth in contact, for any system of interchangeable involute gearing in which the 12-tooth pinion is the smallest. The minimum contact occurs in the case of two 12-tooth pinions in mesh, and the maximum in the impractical case of two racks in mesh. As will be seen, the  $14\frac{1}{2}$ -degree series of whatever height of addendum, gives less than continuous action, being about 0.987. It will also be noticed that below the points of interference for the 12-tooth pinion (represented by the junction points of the maximum and minimum lines with the interference line) the contact is constant. Thus, for a system in which  $\alpha = 20$  degrees and  $S = 1.0$ , the amount of contact between any two gears of the series from 12 teeth to a rack, is constant at about 1.40, while for a system in which  $\alpha = 22$  degrees 30 minutes, and  $S = 1.0$ , the amount of contact varies between 1.36 for a minimum and 1.58 for a maximum. Figs. 3 and 4 show this condition, which indicates that if in any series there is interference in the case of the two pinions having the smallest number of teeth allowed by the series, the amount of action obtained in that case is constant for any other case throughout the whole series, up to that of two racks meshing with each other. As far as the author knows, this condition has never before been noticed.

In Fig. 3, which shows two minimum pinions of a series meshing with each other, the action is limited to the line *CD*. In Fig. 4, which shows the minimum pinion meshing with a rack, the action is still limited to the same line *CD*. It cannot extend beyond *C* in one direction, because it cannot pass the point of tangency in the base circle of the pinion. It cannot pass beyond *D* in the other direction, because the points of the pinion teeth are corrected beyond the interference circle, losing their true involute form. In the case of any other gear meshing with a rack, the action is limited to *C* on one end owing to the correction for interference of the points of the rack teeth, and at *D* on the other end owing to the correction for interference of the points of the gear teeth. And in the case of any two gears, the action is similarly limited to the line *CD* by the corrections for interference at the points of the teeth. As may be seen, then, a pure involute system in which  $\alpha = 14\frac{1}{2}$  degrees and  $S = 1.0$ , just fails of continuous conjugate action in the case of any two gears of the series.

The formula used for calculating the maximum curves of Fig. 5, above the interference points, is as follows:

$$n = \frac{2S}{\sin \alpha \times \cos \alpha \times \pi}$$

The formula used for calculating the minimum curves is as follows:

$$n = \frac{2}{\pi \cos \alpha} \left[ \sqrt{(6 + S)^2 - (6 \cos \alpha)^2} - 6 \sin \alpha \right]$$

The formula for calculating the interference line, which gives the contact below the interference points, is as follows:

$$n = \frac{12 \tan \alpha}{\pi}$$

One of the great practical advantages of the involute gear is the possibility of varying the center distance without interfering with true conjugate action. The comparative amount of separation possible for any two proposed systems, without losing continuous action, may be estimated from Fig. 5 by comparing the amounts of continuous action for the two cases. Naturally the one having the greater number of teeth in continuous action will stand more separation than one which has less. This point could be calculated, but by processes so devious that it did not seem worth while to spend the time for it.

With increase of the pressure angle there is an increase in the side pressure on the journals. Since the side pressure on the journals is the resultant of the tangential pressure between the mating teeth at the pitch line, and the radial outward thrust due to the angularity of the meshing surfaces at the pitch line, it varies directly with the secant of the angle. The curve shown in Fig. 6 is therefore a secant curve.

The rational formula for the strength of gearing is the well known one developed by Mr. Lewis.\*

As the strength varies directly with his factor  $y$ , this factor forms the basis of comparison for different forms of teeth.

Fig. 7 shows the maximum and minimum values of  $y$  for certain selected forms of gear teeth. It will be seen that the values of  $y$  rise rapidly with the decrease of the addendum, and more slowly with an increase of the pressure angle, which does not affect it so much.

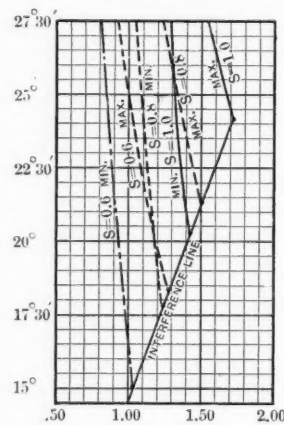


Fig. 5. Maximum and Minimum Number of Teeth in Continuous Action.

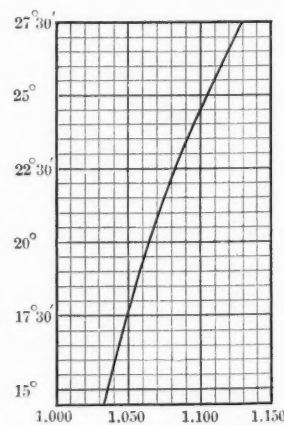


Fig. 6. Side Pressure on Bearings.

Fig. 8 shows that the values obtained for  $y$  vary somewhat from those obtained by Mr. Lewis (it will be noted that his values have been multiplied by  $\pi$  to make the formula read for diametral pitch). This variation is probably due to the fact that in this investigation the outlines from which the factors are calculated have their teeth corrected for interference, thus bringing the normal pressure at a greater angle at the points of the teeth; and to differences in the method of laying out the fillets.

The work lost in friction in the case of two gears meshing with each other is proportionate to the product of the rate of sliding and the normal pressure on the surfaces in contact. This rate of sliding varies directly with the distance of the point of contact from the pitch point *O* (Figs. 3 and 4, etc.) of the gears. The pressure is constant throughout

\* Kent's Pocketbook, page 901.

the action, except that when two teeth are in contact it may be considered that the pressure is evenly divided between them. The diagram in Fig. 9 was calculated by a modification of the method devised by an English engineer, Mr. Bruce.\* The calculations are made for a single case of gearing, an 18-tooth pinion driving a 60-tooth gear. This case was selected as typical.

The diagram for durability is shown in Fig. 10. The wear between the teeth of two gears is proportionate to the continued product of the pressure, the rate of sliding, and a third factor which depends on the shape of the surfaces in contact. This factor is greater for sharply curved convex surfaces and less for a large radius curve rubbing on a flat surface, for instance. This being the case, it seemed to the author that a reasonable basis of comparison for different

setting. The cutter may be set out of center, or set deeper than required, or have its face ground at an angle considerably away from the radial plane required to give the true cutting shape. The standard form of gear tooth, developed by the Brown & Sharpe Manufacturing Company, has been improved by long practical experience, to a point where it takes care of these practical inaccuracies in a very satisfactory way.

#### Relative Importance of the Various Considerations.

As to the importance of the various considerations mentioned above being affected by changes of the pressure angle and addendum, it may be said that the difficulty due to interference (apart from its effect on strength, efficiency, etc., which is considered under those heads) is that of making the shape of the gear indeterminate. The design of the standard gear is empirical. While the writer has followed the plan of making the flanks of the 12-tooth pinion radial, and generating the fillet by means of an extended and rounded rack tooth, produced by such a radial flank, he does not know that this is the form of the standard tooth. The exact form is known only to the makers of standard cutters and is not public knowledge. It will be seen that this matter of interference makes of the standard system practically a short tooth system so far as the theoretical bearing is concerned. This is plainly shown in Fig. 11, for Case 1, which is the standard involute gear tooth. The bearing extends over but a very small part of the tooth faces and flanks. The bearing can, of course, be carried clear to the points of the teeth by making the non-involute parts of the teeth on some other conjugate system. This would give more action than Fig. 5, but since only a part of it is involute, the excess of action would be lost as soon as the center distance is changed. A conjugate correction of this kind is made by the manufacturers of standard cutters.

The number of teeth in continuous action, shown in the diagram of Fig. 5, is of importance principally in relation to smoothness of action. It is not generally considered possible to count on distributing the load evenly between two teeth in calculating the strength of gearing, though it will be noted that where  $n$  is slightly more than unity, two teeth are in bearing at the beginning and end of the action, when the fiber stress in the teeth is at the greatest. In the matter of smoothness of action, it is necessary to have one pair of

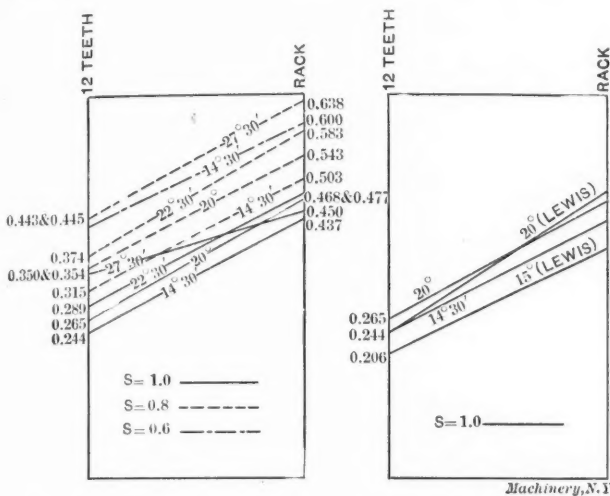


Fig. 7. Maximum and Minimum Values of Strength Factor for Typical Cases.

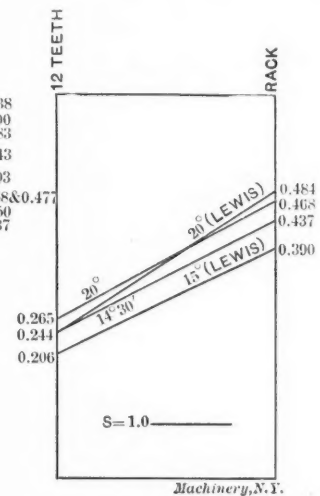


Fig. 8. Comparison of Values for  $y$  Here Obtained with those Calculated by Mr. Lewis.

systems of gearing could be made by multiplying the values given in the diagram of Fig. 9 by a factor determined from the shapes of the surfaces in contact, and plotting the reciprocal. In determining this factor, the author has followed Mr. C. H. Logue,† who obtains it by adding together the sums of the curvatures (that is, the sums of the reciprocals of the instantaneous radii) of the gear teeth at the pitch line. This should give a value which is approximately an average of the conditions existing throughout the entire action. (It should be understood that Figs. 9 and 10 indicate comparative values only. Positive calculations of efficiency or durability are not here contemplated.)

The question of permanency of form may be considered aside from that of durability. By durability we mean the lasting quality of the gear, without reference to whether or not it keeps its shape in the wearing process. A gear which has permanency to a high degree might wear out very rapidly, but it would retain nearly its true form throughout the whole of its short life. In Fig. 11 is given a series of diagrams showing the tendency of a correctly formed tooth to wear at different points of the tooth outlines, in the case of a 12-tooth pinion and the rack, and for the same pressure angles and addendums that were selected for the strength diagram of Fig. 7.

Besides the various factors for which diagrams are given, there are a number of important ones of such a nature as to be incalculable. One of these factors is the suitability of a system for use in different methods of tooth cutting. Any form of tooth which involves interference is very unsatisfactory for use in any generating process, for instance. The formed cutter process works with equal facility on any form of tooth, except that the increase in the pressure angle gives somewhat more side clearance, leading to a freer cutting action.

The vital incalculable factor is smoothness of running. Smoothness of action depends theoretically on perfect conjugate action between the mating teeth. In practice it depends as well on accuracy of cutting tools and accuracy of machine

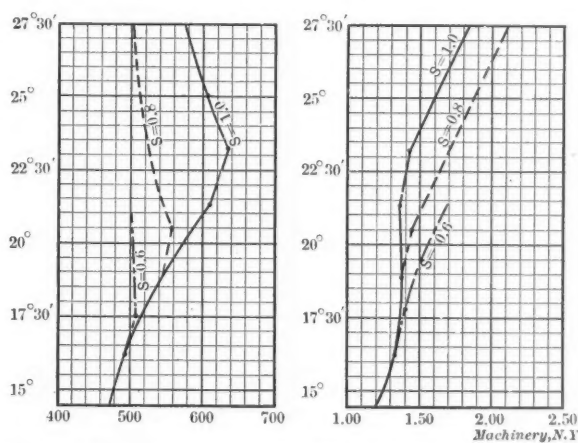


Fig. 9. Comparative Amount of Lost Work.

teeth take up the load before the previous pair drop it. Increased smoothness of action, due to smoothing out irregularities in cutting, could be effected by having two, three or more sets of teeth in action at one time, but this is impracticable with interchangeable involute gearing. A considerable length of contact is also of advantage in permitting a considerable variation in the center distance, without loss of continuity of action, as previously explained. In this respect the increased pressure angles will be seen to have considerable advantage over the standard form.

The side pressure, shown in Fig. 6, is an almost negligible factor. As may be seen, the increase for even so great an angle as  $27\frac{1}{2}$  degrees is only 9 per cent above that given by the standard form. At  $22\frac{1}{2}$  degrees it is  $3\frac{1}{3}$  per cent

\* American Machinist, October 10, 1901.

† American Machinist, February, 1908.

above: As the shaft bearings can take care of this slight increase of side pressure in a perfectly normal and satisfactory way, the question scarcely enters into consideration.

The matter of strength is an important one. If a stronger form of tooth can be used, many mechanisms can be gotten into a much smaller space than is otherwise possible. A case in point is the design of geared speed and feed mechanism for machine tools, in which the space problem is usually serious. By decreasing the face of the gear to correspond with an increase in the strength factor  $y$ , the problem of the designer would be greatly simplified. Instead of reducing the width of the gear by using a stronger form of tooth, advantage can be taken of the stronger form to increase the number of teeth and make them of finer pitch. This gives smoother action, owing to the small inaccuracies in the fine teeth. Smoother action at high speed also means increased strength, owing to the lessening of stresses due to impact.

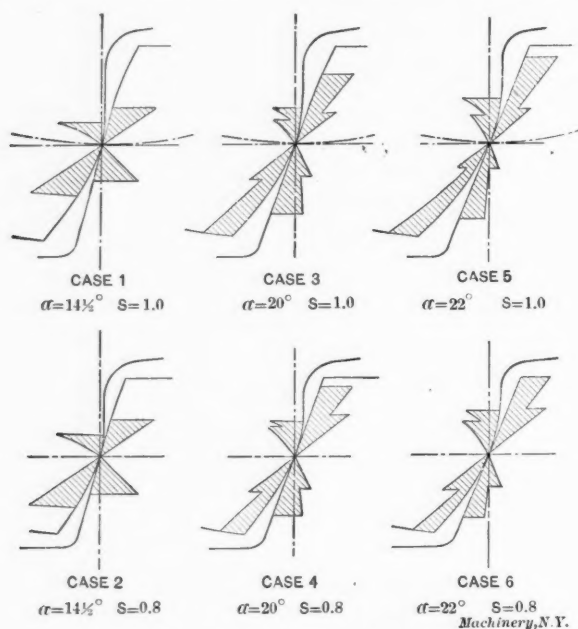


Fig. 11. Permanence of Form.

It is becoming recognized that impact at high speeds is greatly affected by the accuracy of the surfaces in contact; and even where the strength is sufficient, the matter of noise in high speed gearing is of great commercial importance. People would not buy noisy gearing if they could help it, even if it fulfilled their requirements in every other particular.

The question of lost work (plotted in the diagram of Fig. 9) is not a matter of serious moment. The efficiency of well-made spur gearing is so high\* that the slight variations indicated by the diagram are of small practical importance. This diagram, of course, takes no account of the increase in lost work due to increase in journal pressure, which is an inconsiderable factor with well made bearings.

Durability is of much more importance. Gears have been almost invariably designed hitherto for strength rather than durability, but it is becoming recognized that in many cases the principal factor in gear design is the wear of the teeth. If then the methods by which the diagram of Fig. 10 is calculated are rational, the results there shown are of considerable importance.

Permanency of form is another important factor. Gears which the writer has seen worn out in hard service, show very plainly the severe concentrated wear inside the pitch line indicated in Case 1 of Fig. 11. The advantageous effect of an increased pressure angle on permanency is worthy of consideration.

The fitness of a tooth form for various cutting processes is of importance in determining the future of the apparently attractive generating method of cutting gear teeth. One form of generating process has come into extensive use in spite of the handicap of the 14½-degrees angle, with the various corrections for interference required. There is reason to

believe, however, that this process works better with forms of teeth in which the angle is increased or the addendum decreased. Were the change advisable for other reasons, this fitness for generation would be an added advantage, though it would scarcely be worth changing on this score alone. So far as cutting teeth by the formed cutter process is concerned, an increase in the pressure angle is favorable, as more side clearance is obtained for the cutter; while decreasing the addendum gives less volume to cut out, and a consequent cheaper production of gears. It might also be mentioned in this connection that the decrease in face or pitch that could be obtained by the use of stronger forms of teeth, would also result in cheapening the gear, owing to the fact that less metal would have to be removed.

#### Comparison of Typical Involute Tooth Systems.

It is proposed to give, in connection with this discussion of the effect of the variation of pressure angle and addendum, a comparison, by the diagrams herewith presented, of various typical forms of gearing in relation to the practical points just discussed. For the purposes of this discussion the following forms are considered:

- Case 1:  $\alpha = 14\frac{1}{2}$  degrees,  $S = 1.0$ .
- Case 2:  $\alpha = 14\frac{1}{2}$  degrees,  $S = 0.8$ .
- Case 3:  $\alpha = 20$  degrees,  $S = 1.0$ .
- Case 4:  $\alpha = 20$  degrees,  $S = 0.8$ .
- Case 5:  $\alpha = 22\frac{1}{2}$  degrees,  $S = 1.0$ .
- Case 6:  $\alpha = 22\frac{1}{2}$  degrees,  $S = 0.8$ .

Case 1 has the standard pressure angle and addendum. Case 2 is practically the system employed by the C. W. Hunt Co.; 3 is the system used by William Sellers & Co.; and 4 is practically the "stub tooth" system. The last two will show the effect on the Sellers and "stub tooth" systems respectively, of increasing the pressure angle from 20 to 22½

#### COMPARISON OF SELECTED EXAMPLES OF INVOLUTE GEAR-TOOTH SYSTEMS.

Point of Comparison.	Case 1. Standard Pressure Angle and Addendum.	Case 2. Hunt Stan- dard (approx- imate)	Case 3. Sellers Standard.	Case 4. "Stub-tooth" (approximate).	Case 5.	Case 6.
Smallest pinion in series to avoid interference.....	32	26	17	14	14	11
Maximum number of teeth without correction for interference with 12-tooth gear.....	None	None	None	36	35	Rack
Maximum and minimum number of teeth in continuous contact.....	0.98	0.98	1.38	1.38	1.58	1.44
Proportion of side pressure on bearing to tangential pressure.....	1.033	1.033	1.064	1.064	1.082	1.082
Strength factor of rack.....	0.437	0.503	0.468	0.543	0.477	0.583
Strength factor of 12-tooth gear.....	0.244	0.315	0.265	0.354	0.289	0.374
Comparative loss of work from friction.....	475	475	572	552	628	532
Comparative durability.....	1.21	1.21	1.39	1.44	1.40	1.63
Permanency.....	See Fig. 11	.....	.....	.....	.....	.....

For incalculable factors, see text.

degrees. The table, in which these various forms with their corresponding advantages and defects are tabulated, suggests that by a change in the present standard of gearing, marked advantages could be obtained on the following scores: avoidance of interference, giving a greater number of teeth in true involute action, and permitting more separation with continuous contact; increase of strength; increase of durability; increase in permanency of shape; and increase in fitness for generation and cutting by formed cutters. On the other hand, such changes mean an increase in side pressure, comparatively little change in efficiency, and an incalculable

\* Mr. Lewis' Experiments, Kent's Pocketbook, page 899.

and unknown change in smoothness of action. Side pressure and efficiency (as has been shown) are of comparatively minor importance. Smoothness of action is of prime importance. The results of a change in this respect can only be arrived at by learning the experience of the users of the various forms of gearing.

It should be noted that the above comparison relates to pure involute action only. As the shape of the non-involute portion of the standard tooth is not public knowledge, it was impossible for the author to analyze its action. Could it have been analyzed, it would doubtless have shown better results for the standard form in Figs. 5 and 11, and not quite such good results in Figs. 9 and 10.

Whatever the condition relative to high speed work, however, it seems to the author that the preceding discussion points clearly to the wisdom of an alternative gear tooth standard of shorter addendum and increased pressure angle for such work as heavy mill gearing and slow speed gearing in general, in which smoothness of action is not a prime requirement. Increased strength and permanence of form would appeal particularly to engineers whose work permits them to design machinery by rational rather than by empirical methods.

Aside from the specific cases mentioned, correspondence and conversation with makers of cut gearing bears testimony to a growing demand for, and use of, a stronger form of tooth. The adoption of a standard for this work would give all the advantages which come from standardizing; the preparation of tables of dimensions and of strength; the devising of odontographic tables for the fillet at the root of the tooth, and for the correction—if any is needed; and the reduction in the stock of form tools necessary for doing a general line of gear cutting work.

In any event, a standard of gearing of known form, which can be laid out by any engineer who desires to employ it, would be an advantage, if such a consummation is possible without sacrificing any of the good qualities which we are accustomed to expect from the present standard.

#### ALCOHOL AS A FUEL FOR INTERNAL-COMBUSTION ENGINES.

Abstract of article by Thos. L. White in the *Engineering Magazine*, September, 1908.

It is the purpose of this article to consider the suitability of alcohol as a gasoline substitute, and as there are many types of engines, designed to fill widely varying needs, the subject is one which has many sides and may easily be made confusing or misleading unless the issue under discussion is very clearly defined. In considering the difficult matter of changing over from gasoline to alcohol, it is important to remember that the two fuels differ in a dozen essential particulars; that the current type of motor is a gasoline instrument evolved under gasoline conditions; and that the greatest variety of opinion exists as to how far the accepted rules of construction will have to be modified to suit the change. Moreover, there is the important economic fact to be considered that some millions of gasoline motors are at present in use, and that it is not only a sound but a necessary policy to try to maintain their constructional features as far as possible, changing nothing unless there is a distinct necessity for each change, or a distinct advantage resulting from it. That there are to be had special alcohol machines, which are excellent for certain purposes, is beside the real issue which is concerned with using alcohol in the high-speed, low-compression engine.

The evolution of engine types in the past has not been so much along the lines indicated by considerations of fuel economy as along the lines indicated by considerations of handiness, reliability, and flexibility. If alcohol possesses advantages of this character, when burned in the present type of gasoline motor, and if any operative disadvantages incidental to its use (such as difficulties of starting up) can be eliminated, and some increase of efficiency attained by recourse to less radical means than high compressions, then there will be no need to consign the present engine to the scrap-heap in order to be able to burn alcohol. It is the opin-

ion held in this article that alcohol has several such advantages, and that its efficiency in the gasoline motor can be increased without virtual reconstruction. Incidentally, it is well to remember that in the matter of compression there is no golden mean. The gasoline engine compresses to 80 pounds at most, and till this is increased to over 130 pounds, the gain in thermal efficiency resulting is not worth the trouble of the alteration.

While it has always been the aim of designers to make the gasoline motor as flexible as the steam engine, the narrow range within which a charge of gasoline and air can vary in composition and yet remain explosive has always prevented any regulation of the power by the manipulation of the mixture. In the case of alcohol and air, however, the variation of the proportions compatible with perfect combustion is four times as great, and it has been determined by experiment that the specific power of the working stroke of an alcohol engine can be reduced to 25 per cent of maximum, by the operation of an auxiliary air throttle. In automobile practice this means that the adoption of alcohol would tend toward fewer cylinders and simpler gears. The actual limits within which alcohol and gasoline mixtures are respectively explosives are 4 per cent to 14 per cent, and 2 per cent to 5 per cent, tested at atmospheric temperatures and pressures.

The alcohol motor has been severely criticised because of the alleged difficulty in the matter of carburation, which is occasioned by the high latent heat in alcohol. It is difficult to see wherein the drawback from this cause exactly lies, and as far as one can tell the criticism seems to arise from the widespread notion that all preheating of the in-going charge is prejudicial to the efficiency of the motor. The fact is that preheating the mixture *after* the fuel is in a state of vapor is harmful in two ways: First, the whole body of the in-going mixture being thereby expanded, the actual weight of mixture that enters the cylinder during the suction stroke is decreased, so that the specific power of the motor is lessened; second, the efficiency of the motor is reduced, for while there is no lessening of the negative work done during the compression stroke, the energy of the succeeding expansion stroke on which it is a *pro rata* tax is less, there being less fuel present. Preheating the mixture, however, or its constituents separately, within limits and before the fuel (in this case alcohol) has become converted into vapor, has no tendency whatever to rarefy the charge, and is consequently without effect, at any rate on that score, on either the specific power or the efficiency of the motor.

To the question of carburation is closely related the question of starting up from cold. The alcohol motor has been widely attacked in this connection and as widely defended, and the only satisfactory course seems to be to disregard all evidence of a merely general character. Even specific cases cannot be regarded as having much weight, unless the accompanying conditions were normal, for the pertinent issue is not whether a start can be made from cold under the most favorable conditions, but whether a start can be made under any conditions that are likely to occur in practice. The question also seems to be a separate one for each type of motor, technically because the character of the difficulty to be overcome varies with different constructions, practically because the matter is of more importance in the case of the automobile engine than in the case of the stationary engine. The high pressure German motors may be considered separately, as they constitute a class in themselves, being unsuited to burn gasoline. According to the principle adopted for vaporizing the fuel, they fall naturally, for the present purpose, into two divisions respectively, typified by the Durr motor, in which pre-heat is relied on, and the Deutz motor, in which the alcohol is sprayed into the in-going air, vaporization being effected by the aid of the heat generated during the compression stroke. In neither case can a start be made from cold, for in the one the necessary pre-heat is wanting while in the other the compression by hand is too slow to volatilize the alcohol in the mixture.

In the case of the low-pressure or gasoline motor, it is impossible to make any accurate subdivision, the type varying all the way from the farm motor, with a rate of 100

R. P. M. and a ratio of stroke to bore of 2 to 1, to the fastest automobile motor with a rate of 2,000 R. P. M. and a ratio of stroke to bore of 1 to 1. Carefully conducted experiments go to show that when the speed is moderate and a good expansion is provided for, the gasoline motor will start up from cold on alcohol under laboratory conditions, but there is little evidence to prove that any gasoline motor can be set in operation when the circumstances are unfavorable, as, for instance, in moderately cold weather. So far as the fast running type is particularly concerned, the problem is not so much to be able to start up at all times and under all conditions on alcohol, as to be able to run at all on this fuel with any show of efficiency; and there are many reasons for agreeing with the statement of the Fuels Committee of the Motor Union, that the solution lies in combining the alcohol with benzol or acetylene, not merely to facilitate starting up, which is regarded as an incidental gain, but to bring the alcohol nearer in character to gasoline, so that it can be used under the gasoline conditions by which the limitations of the ordinary motor are determined.

The principal difficulties experienced when alcohol is used in the high speed motor, arise from the fact that this fuel ignites slowly, compared with gasoline, and that when ignited the propagation of the flame throughout the mixture is not sufficiently rapid to suit a piston velocity of over 12 feet per second, and a piston travel which, at any rate in the case of the automobile motor, is strictly limited in range. The disadvantages, direct and indirect, which result from this sluggish ignition and tardy inflammation are several, and all important. Combustion, instead of being completed when the compression and temperature are greatest, is continuous during the entire expansion. From a thermodynamical standpoint this means that a portion of the heat units contained in the alcohol are not being liberated to the best advantage. It has been claimed for the alcohol motor that this phenomenon of delayed combustion is a positive advantage, giving a smooth, even thrust on the piston and a high mean pressure. That such an effect has been observed in alcohol motors is beyond doubt, but it must be attributed, not to the sustained inflammation, since it is most noticeable in very slow-running motors in which combustion is completed during the early portion of the expansion stroke, but to the presence of steam produced from the burning of the alcohol and from the water with which this fuel is always diluted. Provided that this steam (which is of course superheated almost up to the dissociation point) receives its heat content at the maximum temperature of the expansion, its presence and action is in every way an advantage, for it represents internal as against external cooling of the cylinder walls, and the retention of heat units in the working fluid, which would otherwise pass into the water jacket.

If, however, the superheat of the steam is regenerated as the expansion proceeds by the continued burning of the fuel, this regeneration is effected at the cost of the thermodynamic loss stated above, a loss which is avoided if the steam receives its whole energy at the beginning of the expansion. To the credit of delayed combustion must be laid not only the work losses due to a portion of the fuel being burned at a disadvantage, but also losses due to a portion of the fuel being only partially burned or not burned at all. The exhaust is found to be contaminated with products of combustion other than water and carbon dioxide, and ceases to be odorless and unobjectionable.

Once it is clear that the problem of substituting alcohol for gasoline as a fuel in the high speed motor, reduces itself to seeking a more vigorous ignition and a more speedy inflammation, and conceded that these desirable ends can be obtained by the addition to the alcohol of some compound which will generally accelerate its action in the motor, the natural suitability of acetylene as a corrective can hardly be overlooked. This gas, which has the same formula of composition as tar benzol, has the further property, which is shared by no other fuel, that it is an endothermic compound. In its formation heat is absorbed, and there resides in the acetylene molecule the power of spontaneously decomposing and liberating

this heat, if it is subjected to a temperature or pressure beyond the capacity of its unstable nature to withstand.

If the liberation as heat of the reserve energy of acetylene (which, it should be noted, is an operation quite distinct from combustion, in that it can take place in the absence of oxygen) is effected when the acetylene is diffused through the body of an inflammable mixture, it is found that each detonating molecule of acetylene becomes a center of inflammation and the whole mass is burned with a speed and vigor that is only limited by the proportion of acetylene present. In the case of alcohol, the practical question is whether the conditions favorable to the spontaneous decomposition of acetylene are induced, when air carburated with alcohol and acetylene is compressed and ignited in the motor in the usual way; and the experimental answer is that they do. The rise of pressure set up in the mixture when the ignition takes place is accelerated by the detonation of the successive portions of acetylene as they are involved in the advancing pressure wave, and it is found that the ignition line in a pressure-volume diagram taken on a motor burning a mixture of alcohol and acetylene is even at 2,000 revolutions, as vertical as the corresponding line in a pressure-volume diagram taken on the same motor when it is burning gasoline.

All denatured alcohol contains a percentage of water, and it is a fact that alcohol containing from 10 to 15 per cent of water is in every respect a better fuel than pure alcohol. The action of the water is very obscure, and it has not been satisfactorily determined how far the percentage can be increased without the consequent lowering of the calorific value of the mixture more than offsetting the benefit in the motor. What is relevant here is that the advantages derived from the presence of comparatively large percentages have been principally experienced in connection with high compressions, and to get similar results in the low-compression high-speed motor, the damping effect of a large admixture of water calls especially for the accelerative action of acetylene on the inflammation and ignition.

In conclusion, if we consider that the automobile motor is an instrument in which power must be sought by high piston velocities, and that starting with Daimler's motor this condition has been accepted without question as the basic canon of construction of this class of engine, it seems almost inevitable that the use of alcohol, in the automobile field at any rate, will continue along the lines of carburating the alcohol.

\* \* \*

It is not improbable that the United States government will soon authorize plans for the construction of a gas-engine battleship. The gas engine and gas producer plant has peculiar advantages for battleships. In the first place, there is the saving of fuel and space—in themselves very important. The chief features of the gas-engine battleship that command the attention of naval experts, however, are the absence of smoke and funnels. The funnels are a great source of danger in time of attack as it is impossible to armor them so as to insure non-penetration, and the smoke betrays the coming of a fleet long before the vessels themselves can be discerned. The strategic importance of avoiding funnels and smoke, therefore, can scarcely be overrated. It is probable that future battleship design will center around the use of gas engines and gas producers as the motive power.

\* \* \*

A great deal of time is spent in the average machine and metal working shop in clearing away the chips which accumulate on drilling and other machines while at work. The application of the rotary pressure blower for blowing these chips away and keeping the work clear, is a recent innovation. By directing a jet of air from the blower directly onto the work a close observation may be kept by the workmen without the necessity of constantly wiping away the chips by hand or with a brush. Perhaps 10 per cent of the total working time on each job would be a low estimate for the operation of simply clearing the work of these chips. This being true, the small cost of a pressure blower pays for itself many times over in doing the work. Besides this, a certain amount of the air may be diverted to other uses at the same time.

## NOVEL PUMP CONSTRUCTION FOR PRESSES.

W. M. FLEMING.\*

Many interesting problems are presented to manufacturers of power pumping machinery, in the adaptation of power pumps to replace the less economical but somewhat more flexible direct-acting steam pump. The Deane Steam Pump Co., Holyoke, Mass., recently supplied a special small triplex power pump equipment for use in connection with a hydraulic

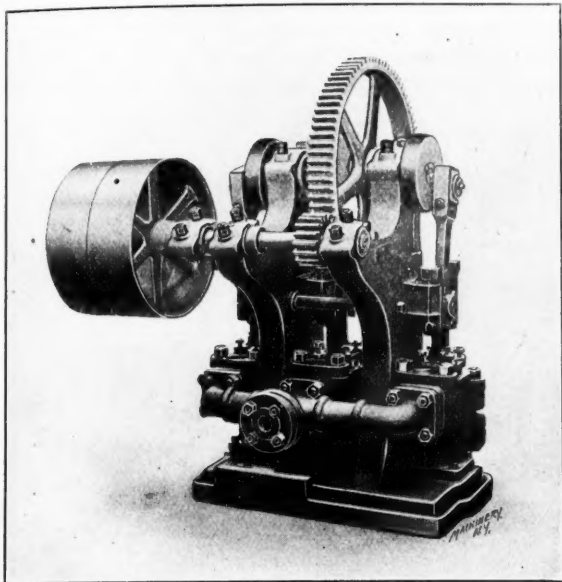


Fig. 1. Low-pressure Deane Single-acting Geared Pump.

press system, which is a case in point. The triplex power pump installation replaces a direct-acting steam pump and materially reduces the cost of operation.

The problem presented to the manufacturer in this case was to provide, for any one of three presses operating successively: first, a comparatively large quantity of water at low pressure for advancing the press ram until it met with considerable resistance, due to the load, and second, to supply a gradually diminishing supply of fluid at gradually increasing pressure, until the maximum desired load on the

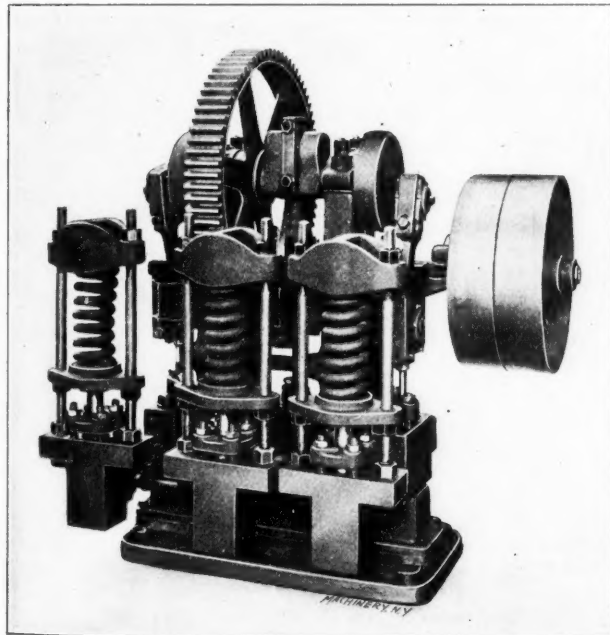


Fig. 2. High-pressure Deane Triplex Geared Pump with Spring Alleviators.

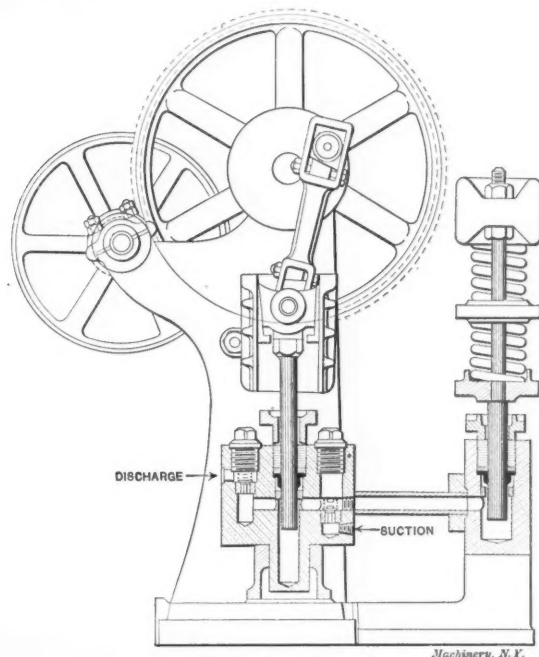
press platen has been obtained, at which point the discharge from the pump must cease automatically, but the pressure must be maintained on the press for a period of several hours.

These peculiar conditions of service were taken care of by the installation of two pumps: a low-pressure and a high-pressure machine. The low-pressure pump is shown in Fig. 1, and as can be seen, is simply a power pump of the vertical triplex outside packed single-acting pattern, designed for a

working pressure of 1,000 pounds. This machine is connected with a header from which water may be drawn through a check valve into any one of the three presses supplied. It is started manually and stopped by means of an automatic hydraulic belt shifter, when the pressure in the header or discharge from the pump rises to 1,000 pounds.

The special high-pressure pump shown in Fig. 2, and in section in Fig. 3, has the discharge from each individual cylinder piped to a press through a proper three-way operating valve, and operate continuously, discharging back to the suction when not to the press. This pump is novel in that it has a separate spring-controlled alleviator directly connected to the pulsation chamber of each cylinder. The alleviators are designed with a capacity equal to the capacity of the pump plunger and the springs of the alleviators are of such size that, when the pressure in the pump cylinder exceeds 1,000 pounds per square inch, the springs just begin to compress. When the pressure rises to 6,000 pounds per square inch, the springs compress to such an extent as to permit the alleviator cylinder to take the entire amount of water displaced by the pump plunger, and under these conditions no discharge from the pump occurs.

As previously stated, there are three presses supplied by the two pumps, the presses being worked consecutively. When the first press is made ready for operation both pumps are



Machinery, N. Y.

Fig. 3. Vertical Section of High-pressure Pump Cylinder and Alleviator.

started manually. The low pressure operating valve is opened, advancing the press ram until the ram strikes the load, and the resistance increases so as to raise the pressure in the discharge line from the low pressure pump to 1,000 pounds per square inch. At this point this pump is automatically thrown out of action. A check valve in the line between the discharge header from the low pressure pump and press No. 1 closes, and the high-pressure pump, Fig. 2, continues to advance the plunger of the press until the maximum required pressure of 6,000 pounds per square inch is reached. As this pressure is approached, the alleviator goes into action and ultimately receives all of the fluid displaced by the pump plunger, returning the fluid to the pump cylinder on the suction stroke of the plunger, thus reducing the load on the pump to practically friction load. The second press is made ready meanwhile, and the low-pressure pump again started manually and the operation repeated on the second press.

From this description and from the drawing, it will appear that this outfit constitutes a very compact and mechanically efficient pumping plant for the service described. The saving of power by its use over the use of the direct-acting steam pump is appreciable, and the use of the low-pressure pump materially reduces the time of what may be termed, inactivity of the presses.

\* Address: 370 Maple St., Holyoke, Mass.

**MACHINE FOR CUTTING OUT METAL SHEETS.\***

The machines illustrated in Figs. 1 and 2 are specially constructed for the purpose of cutting out metal sheets into any desired shape. With them, templets of all sorts, sweeping boards for foundries, and similar pieces can be blanked out with great rapidity. This type of machine is not intended for repetition work, as such work is done more suitably by means of special dies and punches; but it is essentially a machine to replace the hammer and chisel work which is often necessary when only one or two pieces of a similar shape are required.

Two sizes of these machines are illustrated. The one shown in Fig. 1 has a 12-inch gap, is suitable for plates up

mately 0.118 inch thick, and was blanked out in 12 minutes, while the moulder's strickle shown just below it, which is 0.078 inch thick, required but a single minute. Work of this kind can be done so easily that very little practice enables the operator to cut out forms so closely to the previously scribed lines, that a little filing will finish the work.

\* \* \*

**THE DIPLOMATIC DRAFTSMAN.**

TIBBAG.

In the drafting-room of a certain shop manufacturing a number of articles requiring special automatic machines, I once witnessed a deception practiced by one of the draftsmen, that always ended in saving money for the shop, time in get-

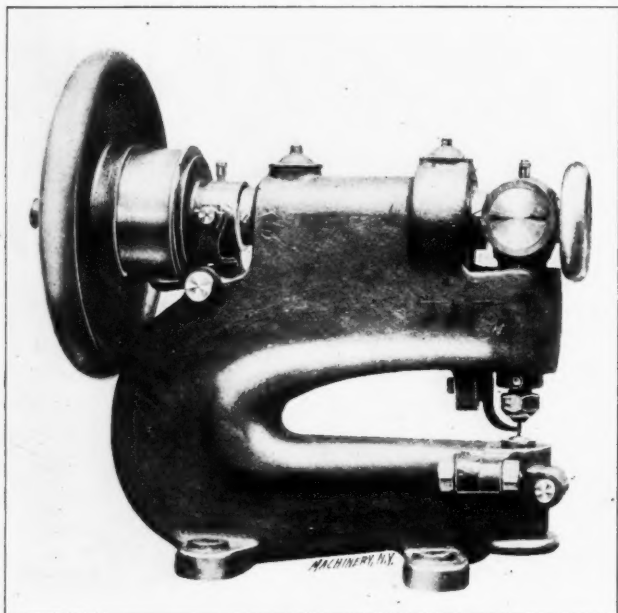


Fig. 1. Machine for Rapidly Blanking out Special Irregular Shapes in Sheet Metal. Size from Punch to Throat, 12 inches.

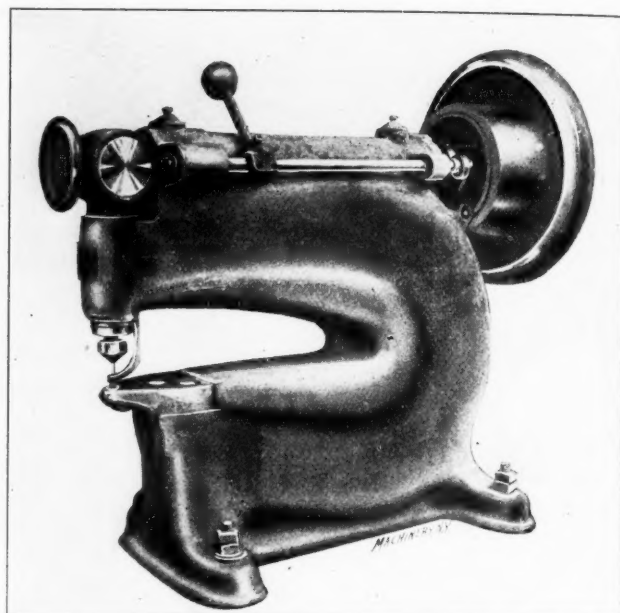


Fig. 2. View, from the Opposite Side, of a Larger Type of the Machine shown in Fig. 1. Size from Punch to Throat, 24 inches.

to  $\frac{1}{4}$  inch in thickness, and runs at comparatively high speed, making 300 revolutions per minute. Fig. 2 illustrates a larger machine, having a gap of 24 inches, but it is also limited to plates having a thickness of  $\frac{1}{4}$  inch or less. The speed of the larger type is 250 revolutions per minute. These machines are provided with a round punch of a special shape, such as shown in the enlarged view at A, Fig. 3. The cutting edge of the tool is in front, and can be set in any direction to suit the work. The back of the punch is prolonged to act not only as a stay for the punch, but also as a guide for the sheet being cut. This extension, which works in the die held in the anvil just below the punch, is long enough to work up and down in this die throughout the stroke. The die can be raised or lowered by means of a screw, to enable the operator to pass a sheet of metal under the punch, so that he may begin to cut at some point in the middle of the plate.

When the machine is in operation, the sheet being cut is guided by the operator so that the punch removes the metal as close as possible to the desired outline previously scribed. The sheet is fed by being pressed lightly against the punch, which causes it to feed inward against the punch extension with each upward stroke. As the end of the punch extension is never above the die, it acts as a guide and greatly facilitates in feeding the work which moves in quite rapidly, owing to the high speed of the machine.

The stroke of the machine is slightly greater than the thickness of the piece to be cut, and the movement is obtained by a special eccentric motion which is illustrated in the sectional view, Fig. 3. As will be seen, an eccentric or off-set pin is journaled in a cylindrical piece which reciprocates horizontally as the ram moves vertically. This method of transmitting the motion from the shaft to the ram greatly simplifies the construction. In the engraving, Fig. 4, the shape of the chip taken at each stroke is illustrated by the dotted lines. In Fig. 5 some of the examples of the work done on this machine are shown. The locomotive connecting-rod templet seen in the upper part of the engraving, is approxi-

ting out the machine, repeated changes in design, and annoyance for the draftsman. This latter result may have been the ruling passion, yet the other things accomplished must not be forgotten. I have somewhere seen diplomacy defined as the art of getting something from the other fellow and at

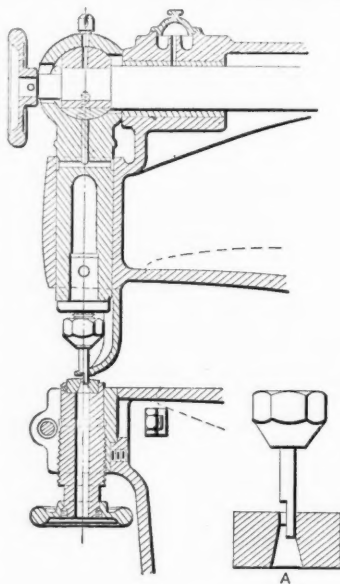


Fig. 3. Sectional View of Reciprocating Parts and Die-holder.

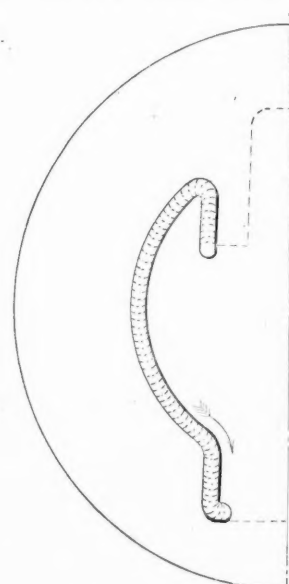


Fig. 4. Half-view of a Templet, illustrating by the Dotted Lines the Successive Punchings.

the same time making him believe that he has gotten something from you. If this is true, then the draftsman in question was a past-master as a diplomat. This game of diplomacy was played with the shop superintendent.

Now the wise superintendent, if he has a machine of a given series to design, will give the draftsman the limits of the product to be turned out on that machine, possibly a few leading dimensions, and leave the rest to him. That

\* Made by Ph. Bonvillain & E. Ronceray, 9-11 Rue des Envierges, Paris, France.

is, if he is a good draftsman—but a wise superintendent never has anything but a good draftsman. He may get the others a little cheaper, but they are expensive. The superintendent of the shop in question was a wise superintendent, for he did all of the above named things, but he was unwise inasmuch as he did not let it end there. He wanted to get into the detail of design too much. He wanted to see that a cam face was not  $\frac{1}{8}$  inch too wide when  $\frac{1}{4}$  of an inch would have made no great difference. With this characteristic fully developed, it was his habit each morning during the hour devoted to the drafting-room, to change the diameter of a shaft  $\frac{1}{4}$  inch, the width of a slide  $\frac{1}{2}$  inch, the diameter of a cam roller or its stud by some small amount until, by making a few changes small and inconspicuous in themselves, he had mapped out enough changes, erasures, moving of parts, etc., necessary to accommodate these minor changes, to keep the draftsman busy about all day. He also had a habit of impressing the draftsman with the fact that the changes must be made, and the changes were made. During the next week, however, things that had appeared too light, might, when changed, seem too heavy, thus necessitating another alteration.

Do you wonder that it was discouraging for the ambitious man to work there? Do you believe me when I say that the drafting force was continually changing and that it was hard to keep a good man?

There were in the drawing-room only a draftsman, tracer and blue-print boy—the latter two embodied in one person who

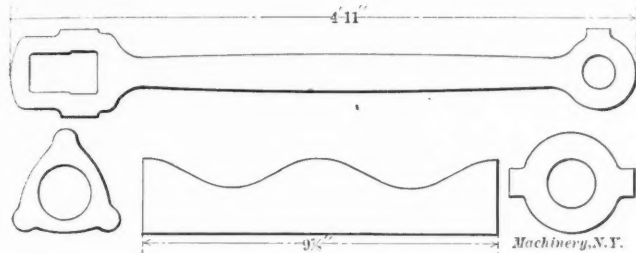


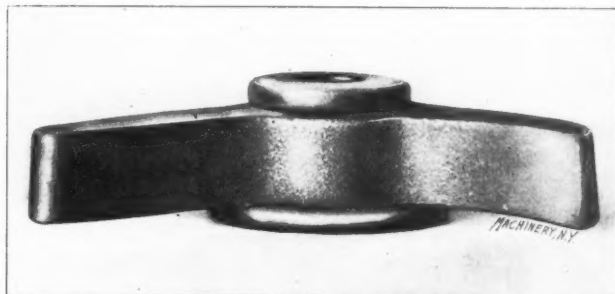
Fig. 5. Examples of the Work for which the Machine is Adapted.

seemed to be a fixture. The draftsman was, however, a transient: First, because the superintendent knew a good man when he saw him work and unless he was good would soon get rid of him; and, second, because the good men would not or could not stand the dictation of the superintendent and would leave. At last, along came a man, "the best man who ever pushed a pencil over a piece of paper," according to the statement of the superintendent. Not only was this man a good draftsman, but he was also a good reader of character. He seemed to size up the superintendent immediately, and, at the same time, seemed to know just how to handle the situation. I have seen him repeatedly lead the superintendent over the parts that he had been accustomed to change, to some minor part, usually something that would not affect the parts already designed, and discuss this with an energy that would make one believe that it was the only vital part of the machine. Over and over again would the two men study this part until the time came for the superintendent to go, or until he was called away. He usually went away with the remark that he would take that up the next time; and, under the artful guidance of the draftsman, he usually did. Thus did the draftsman guide the superintendent from part to part in such a way that the changes made did not affect the previous design. The draftsman was happy, more work went through the drawing-room, there was a more systematic progression in the designs, there were no changes in the drawing force, and there was a superintendent who was better satisfied, less anxious, and had a lighter burden to bear. I know the superintendent was better satisfied, for his visits to the drawing-room were less frequent, and I have once or twice heard him remark, "If there is anything you want to talk over with me on this design call me in, otherwise go ahead."

This confidence in the man was not due to his great ability as compared with those preceding him, but can be attributed only to the fact that the draftsman had educated the superintendent to the fact that minor changes are not necessary in

machine design. The draftsman, too, was wise enough to call in the superintendent and discuss at length any of the essentials with which he was not familiar. At no time during the period in which the man was a draftsman, and up to the time he was made assistant superintendent, did he appear conceited or in any way pretend to know more than the superintendent. I believe this to be one of the greatest helps.

I want to be just to the superintendent and speak of his good qualities as I have of his weaknesses. He was a wonderful man as a shop superintendent, leaving the details of the several departments to his foremen, having the confidence and esteem of the workmen, and at the same time making



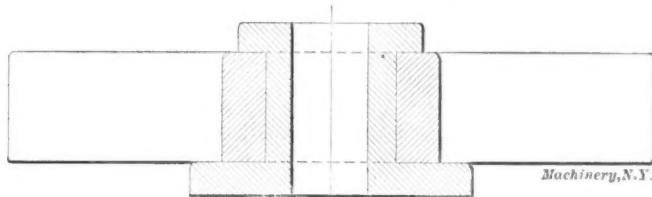
A Casting Puzzle—The Bushing with Flanges is One Piece and is a Loose Fit in the Pawl.

dividends for the company every day. Had the drawing department been a large one with a chief and a number of men, I believe his attitude would have been the same as toward all other branches of the factory and that he would have left all details to the man in charge. He had but to learn that the small department could be handled in the same way.

\* \* \*

#### CASTING PUZZLE.

The accompanying half-tone illustration and line engraving illustrate a difficult piece of casting made by the Taylor & Fenn Co., Hartford, Conn. The casting is a brake ratchet pawl with bushing, used on street railway cars. Both the bushing and the ratchet are solid castings. It will be a puzzle,



Cross-section of Brake Ratchet Pawl and Bushing.

we expect, to most mechanics to figure out how this work is accomplished. The clearance between the two castings is only a few thousandths inch.

\* \* \*

An ingenious and simple method of cutting master plate cams to accurate lead, is used in the shops of the Windsor Machine Co., Windsor, Vermont. Suppose, for instance, it is desired to cut a plate or disk cam having a portion of its periphery formed with a uniform rise, at the rate of 1.360 inch to a revolution of the cam. The blank is mounted on a work arbor in the usual way, and a plain cylindrical cutter of sufficient length is clamped in place on the spindle. The indexing is set for a number of spaces obtained, for instance, by dividing the lead per revolution by 0.005. This gives  $1.360 \div 0.005 = 272$ . The blank is adjusted at the proper height for the cutter to machine the top of the desired rise. The dogs are set as when cutting gear teeth, and the slide runs back automatically, the work indexes and the cutter feeds forward again. During the indexing the work head is fed downward by hand 0.005, the number of thousandths agreeing with the number used for dividing the lead to get the indexing. This combination of the automatic feeding and indexing of the machine, and the feeding of the head down 0.005 inch at each indexing, is continued until the required cam outline has been completed. The working edge is then carefully dressed off with a file, after which the master cam is ready for use.



top of the table. It may be set in this position by testing the top surfaces of the threads at either end with a surface gage. Set the pointer of the gage so that it just touches the top of a thread and measure the distance  $x$  from the pointer to the arbor. Subtract from this dimension the difference between the radii  $r$  and  $r_1$  of the arbor and worm, and the result will be the center distance  $C$ . If the worm is accurately made and the worm-wheel blank turned to the exact dimensions, this center distance should be very close to the distance required. If necessary, the hob may be again engaged with the wheel and another light cut taken. When testing the center distance, as explained in the foregoing, it is better to lower the knee sufficiently to make room for the worm beneath the hob, and not disturb the longitudinal setting of the table, as the relation between the wheel and hob will then be maintained, which is desirable in case it is necessary to re-hob the wheel to reduce the center distance.

When worm-wheels are made in large quantities, they are cut in machines especially designed for this purpose, in which the wheel blanks, instead of being mounted on a free-running arbor, are driven by gearing at the proper speed. This makes gashing the blank previous to hobbing unnecessary, as the change gears insure a correct spacing of the worm-wheel teeth.

### BENDING STRESSES IN CAR TRUCK ARCH BARS.

W. E. JOHNSTON.\*

The stresses occurring in bent and offset rods and bars appear to be underestimated rather frequently. A particular instance of this is met with in the design of the bottom arch bar shown in Fig. 1. Several of these gave indications of

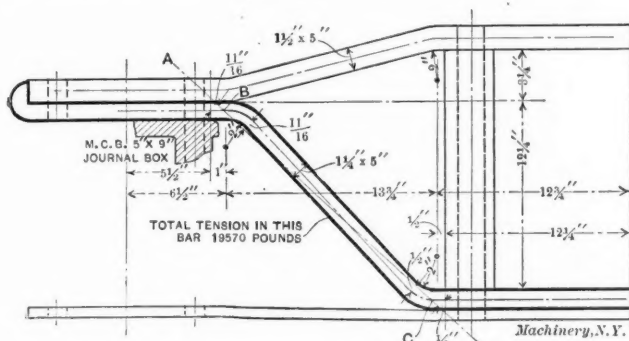


Fig. 1. Data of Railway Car Truck Arch Bar.

weakness in service with loads as indicated. The material in the bars was the usual grade of arch bar iron.

In calculating the stresses in this bar, the first step is to locate a center line so as to determine the amount of the offset, which is the lever arm on which the tension in the bar acts to produce bending moments and resultant stresses in addition to those due to direct tension. It is apparent that when the load comes on the bar, it will bend down over the edge of the journal box, and up around the edge of the column, and the two bends will straighten out slightly, as shown exaggerated for clearness in Fig. 2, which indicates the character of the stresses set up by these deflections. Assuming that the journal box bolts and column bolts are tight, so that the arch bar is held firmly to the journal box and columns, without deflection between the bolts, the portions of the bar extending out beyond the edge of the journal box at the top and the column at the bottom will act as beams, rigidly fastened at one end and loaded at the other, carrying the load out toward the adjacent bends to the points where the bending moment reverses. The bending moment reverses midway between the bends also. A line  $AD$ , Fig. 2, drawn through points  $B$  and  $C$  on the lines of reversal, will be the center line of the pull on the bar, and the length of a perpendicular to this line from any point on the center line of the bar itself, between the bearing on the journal box and columns, multiplied by the pull, will be the bending moment acting on the bar at that point.

\* Address: Northern Pacific Railway Co., St. Paul, Minn.

Since the section of the bar is uniform, it will be sufficiently accurate for practical purposes to draw the line  $AD$ , Fig. 1, so that the perpendiculars on it from the center line of the bar at the edges of the bearings on the journal box and columns, will be equal to the longest ones that can be drawn from the center line at the adjacent bends. In this case, these perpendiculars are  $11/16$  and  $1/2$  inch respectively, as shown in Fig. 1, and will be the lever arms on which the force  $P$  will act to produce bending moments. The total pull  $P$  is about 19,570 pounds. The area of the bar is  $5 \times 1 1/4$  inch =  $6 1/4$  square inches. The stress, due to direct tension, is then

$\frac{19,570}{6.25} = 3,130$  pounds per square inch. The greatest offset is

$\frac{11/16 \text{ inch}}{6} = \frac{5 \times (1 1/4)^2}{6} = 1.302$ . Consequently, the

fiber stress on the inside of the bend below  $B$  is  $f = \frac{Pl}{S} =$

$\frac{19,570 \times 11/16}{1.302} = 10,333$  pounds, due to bending. The total

tensile stress on the inside of the bend is evidently the sum of the stresses due to straight tension and to bending, or  $3,130 + 10,333 = 13,463$  pounds per square inch, or about  $4 1/3$  times that due to the direct pull alone. As a matter of fact, the journal box and column bolts are seldom tight, and the consequent deflection in the bar above the journal box and below the columns will increase the offsets at the bends slightly, and the maximum stresses due to bending are actually a little greater than calculated above. However, since the upper arch bar and the tie bar are in more or less inti-

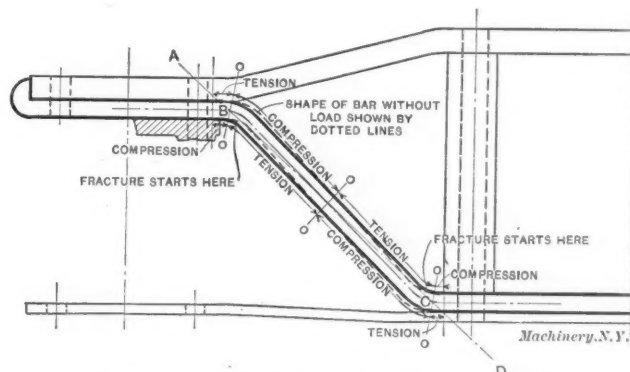


Fig. 2. Illustrating Character of Stresses in Arch Bar.

mate contact with the bottom arch bar, and assist to some extent in keeping it straight, the difference is probably very small.

Examination of some of the broken arch bars confirmed the opinion that the breakage was due to excessive tensile stresses on the inner sides of the bends, as the fracture always started on the inner side at or near the point of greatest offset, some occurring at the top and some at the bottom. It seems, therefore, that large radius bends in arch bars are an element of weakness rather than of strength, unless they are made to fit the journal boxes and columns reasonably closely. By curving the edge of the bearing on the columns and making the radii of the bends in the arch bar a little greater than those on the journal boxes and columns, but with the centers on the same vertical line, probably the best possible results will be secured, the difference in the radii being made just sufficient to cover the unavoidable inequalities in the forgings and castings.

During the past few years the coinage of penny and half-penny pieces in England has been extraordinarily heavy, and the cause has been ascribed to the introduction of the "penny-in-the-slot" machines placed in the railway stations and public places. Last year an officer of the British mint estimated that not less than £250,000 (\$1,250,000) is permanently locked up in these machines and withdrawn from circulation. A single company, it is stated, in twelve months, took no less than 33,984,671 pennies out of their machines.

### NEW DEVELOPMENT IN STEEL CASTINGS.

Every mechanical engineer is familiar with steel castings, and probably every one has often employed them and wished that he could be justified in a much wider use; but difficulties of quick supply, of uncertainty of sound castings, of all too frequent hard spots, of rough surfaces, of washed cores, of obliterated finer details, of inability to get thin sections, of drawing and weakness at rib joints, have each or all compelled a resort to much heavier gray iron castings or to expensive bronze castings, or to even more expensive forgings.

When the engineer is told that he can get castings in steel within twenty-four hours, with no hard spots, with a surface as good as gray iron, with absolutely sound material one thin machining cut below that surface, without blowholes or coldshuts; that he can give himself a free hand in design even to the extent of committing the hitherto unpardonable sin of running a quarter-inch or even thinner rib into a two-inch or heavier section and with a fillet of a quarter-inch

details, present themselves. Modestly showing itself is a gear cutter, near the left-hand of the lower shelf, that is cast from high carbon steel, finished and hardened just as though it had passed through the blacksmith's hands instead of the molder's flask; better still, nothing in its behavior will ever let the user suspect its unorthodox origin. Near it is a hollow casting, with thin, circular heat radiating ribs; work of this character is considered creditable to the gray iron founder when as clean and sharp as this, but was not heretofore considered as even a possibility for the steel founder. On the next shelf at the extreme right the peculiar double crescent terminating in the cross-cored hollow stem involves walls of only one-eighth inch thickness; yet perfectly clean, sound, uniform material and as clean core surfaces as are ever found in gray iron are its characteristics.

Further along the clean work of the cast bevel pinions compels the admiration of those who know. That holds also for the tortuous snakelike exhaust manifold with its very thin cooling ribs to be seen on the same shelf at the left.

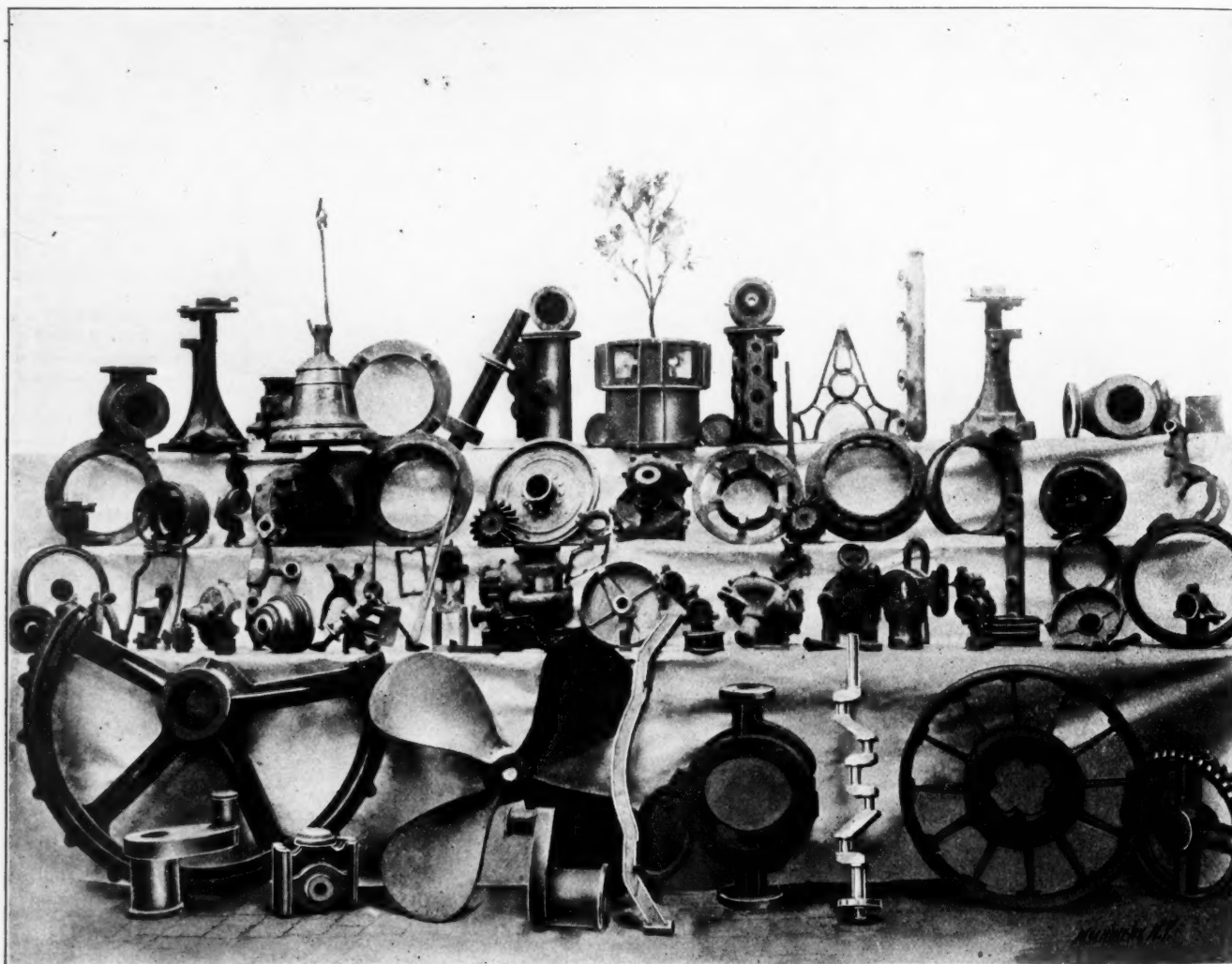


Fig. 1. Group of Steel Castings made by German process, illustrating Great Variety of Applications.

radius, and do that without fear of drawing or weakness in the corner—that engineer will shake his head incredulously.

When the engineer is further told that he can get all of this and practically make his own suggestions as to elastic and ultimate limit, elongation and contraction per cent, and can specify carbon, tungsten, nickel, manganese, vanadium and other alloys exactly as he would for bar stock or forgings—then that engineer may be pardoned if he considers that his informant is either trying to fool him or has himself been fooled. But such castings are here, and are shown in the accompanying illustrations.

The collection of steel castings shown in Fig. 1 is fairly comprehensive; at the bottom there are cranks, crosshead, propeller, auto truck axles, gasoline engine crankshaft, truck-wheel and worm-gear. On the shelves above, a heterogeneous collection of sections of light walls, complicated corework, light ribs with almost feather edges and all with sharp

Passing by the ship's bell and other objects on the top shelf with a mere glance, the eye is held by the spray of oak leaves. The material would have made glad the heart of Tubal Cain, for the leaves are forged and shaped cold from cast test bars of soft steel, practically wrought iron, and the stems welded.

The wheel at the bottom right should have received more than mere passing mention; doubtless the designer had his own reasons for the extraordinary combination of light spokes and heavy rim; the maker of these castings has no fault to find, for being afforded this opportunity to show that light spokes joined to heavy hubs or rims, are all easy to him and that he could, as a matter of every-day work, surmount difficulties that are alike beyond the gray iron founder as beyond the steel founder not possessed of the new knowledge.

In Figure 2 the larger central piece is a valve used by the German Navy to withstand pressures of 2,250 pounds per square inch. The faces of the flanges all have a light cut

taken off in accordance with the specification. Most remarkable is the spidery support of the central stem guide hub. A critical examination of the line section of Fig. 3 of this casting disclosing its complicated coring and thin, quarter-inch, walls abruptly joining the three-quarter-inch heavy flanges, first creates distrust of the possibility of the production of this thing in steel, then surprise and admiration as

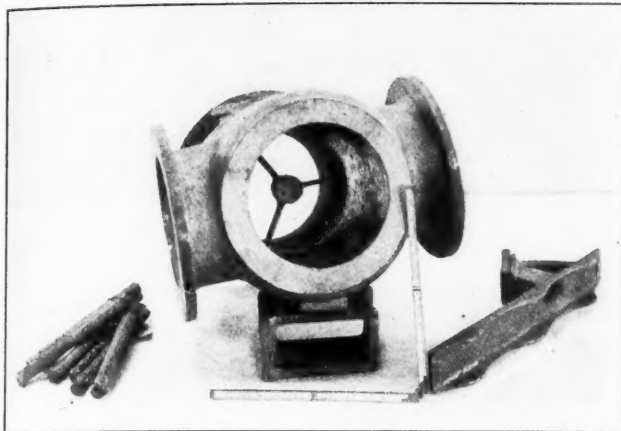


Fig. 2. Thin Steel Casting Valve Body for German Navy, carrying 2250 pounds Pressure.

the photograph and actual casting are viewed. Originally this piece was made of a light grade manganese bronze; even then a large percentage failed to pass the inspection pressure test. In this much cheaper steel casting wastes are altogether negligible.

Referring again to Fig. 2, the casting supporting the valve is a German railway truck detail. The piece to the right is not a carpenter's plane; but a portable yardsman's brakeshoe as used in German freight yards; it must be and is very light; the edges thin down to one-eighth inch. At the left is a bundle of cast test bars.

The group of Fig. 4 will interest the automobile engineer more particularly. The bevel gear housing, the steering gear details, the crank-shaft and the exhaust manifold all show clearly the clean-cut quality of the surfaces, the sharp definition of detail, the quality that makes a cast crank-shaft feasible, the remarkable coring and thin walls, that are all characteristic of this virtually new art of steel founding.

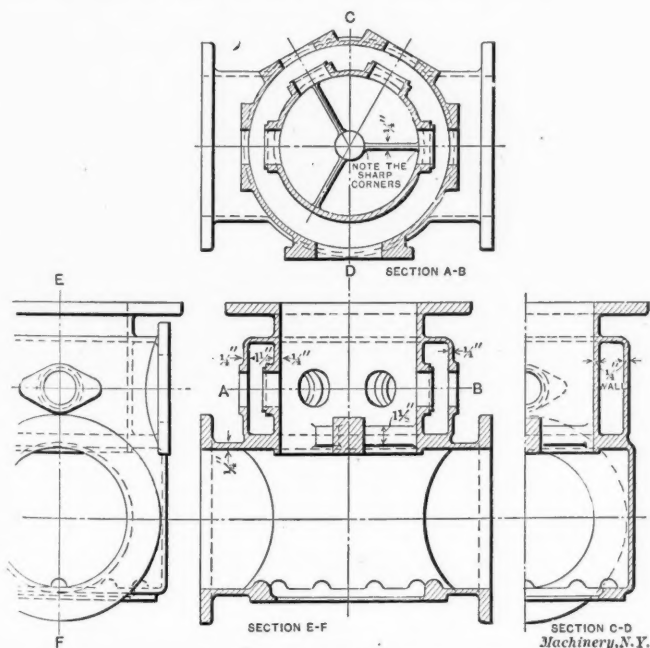


Fig. 3. Detail of Steel Casting Valve Body, showing Thickness of Walls.

The small disk lying against the bevel gear housing of Fig. 4 is deserving of passing mention; it is cut from a cast bar of carbon tool steel of 85,000 to 100,000 pounds tensile strength and 4 to 6 per cent elongation. The cross-section shows that the unevenness of the scale or skin is not a sixteenth inch deep, and that the entire material is as sound as any hammered and carefully forged bar-stock.

The majority of the castings shown in Figs. 2 and 4 are a standard composition known as extra ductile weldable; that has 25,000 to 27,000 pounds elastic limit, 49,000 to 53,000 pounds ultimate strength, 26 to 27.5 per cent elongation and 41 to 42 per cent reduction of area; these are qualities characteristic of only the best Swedish iron forgings. The next standard melt gives about 70,000 pounds ultimate strength, and after that about 100,000 pounds is frequently supplied.

Other special physical characteristics or desirable alloys are furnished as required. The minimum quantity must be one crucible charge of 200 pounds. The only limitation is that the specification must be one that is procurable in rolled or hammered bar-stock. Cutters in self-hardening or high-speed steel of simple or complicated shapes are a regular output. The usual heat treatments, as oil tempering, hardening, etc., that are employed with forgings and bar stock are applied to these steel castings also whenever they are of the corresponding composition.

As to the process itself, that is founded on the well-known crucible type. The novelty resides in the addition to the crucible charge compounded in accord with the specified analysis, of a "bomb" or "pill" that imparts the fluidity, smooth flowing and gas free qualities that make possible the avoidance of the various ills of the ordinary process. That suitable melting arrangements, molding methods, sand com-

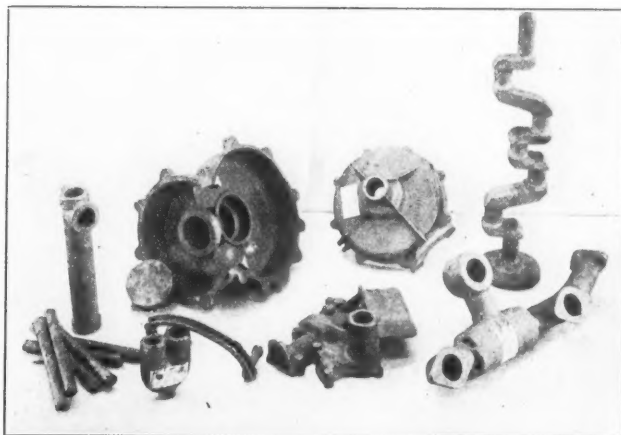


Fig. 4. Automobile Parts made in Steel by German Casting Process.

position, facings and many other apparently minor matters go to the attainment of the final result, is evident enough to all familiar with the older processes. Further details that would interest the practical founder are not yet ready for publication.

The process was originated in Germany where it has been worked near Berlin for four years on a fairly large scale. The various large electrical companies use certain grades for their field magnets because of the remarkable permeability and great density and freedom from blow-holes of the soft grades; Lahmeyer, f. i., uses certain mixtures for high speed turbine work. The locomotive builders are permitted to use these castings where the government that owns all the railways in Germany excludes all other steel castings. Automobile builders consume considerable quantities. Governmental as well as private naval establishments are heavy consumers. The general machine industries take up considerable in gear blanks, with cast as well as blocked-out teeth. Strange to say, even grate bars that are usually made of the very cheapest of cast iron, are an increasing product; this is because the very soft grade possesses a very high resistance to heat, does not warp or burn, and has a life so much in excess of the cast iron as to justify the higher first cost.

Mr. Henry Hess, president of the Hess-Bright Mfg. Co. of Philadelphia, Pa., has acquired the process for North America, and is preparing to establish the industry here. Castings will be imported during the interim until the American plant is at work.

\* \* \*

The total length of street and interurban lines in the United States operated by electricity is now more than 38,000 miles. There are still 776 miles of street railway operated by cables, steam, or horses.

## LETTERS UPON PRACTICAL SUBJECTS.

Articles contributed to MACHINERY with the expectation of payment must be submitted exclusively.

### IRONWORK ORNAMENTATION OF A MECHANIC'S HOME.

The accompanying half-tone illustrations show a city door yard in Greater Pittsburg, which is the result of the labors of a mechanic during Saturday afternoons and holidays for a period of two years. A helper was employed occasionally. The novelty of the work is that the greater part of the ornamental ironwork shown is waste from a machine shop and scrap from a scrap iron yard, even the fence being procured in a scrap yard, minus posts, hinges, scrolls, and other ornaments. The house is on the corner of two streets.

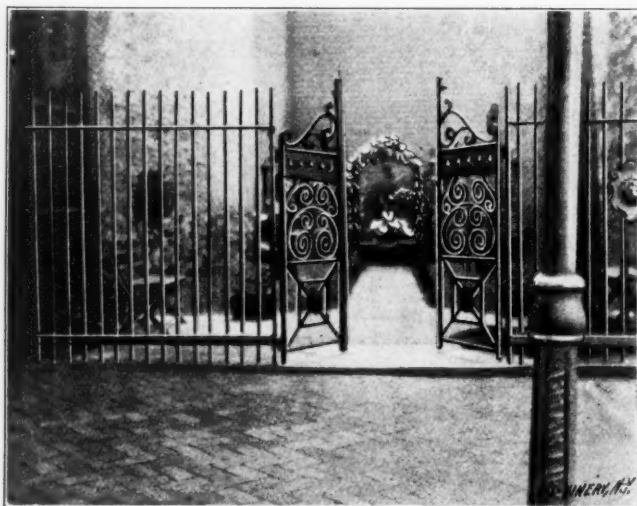


Fig. 1. Front View of Yard with Ornamental Fence and Gates.

imbedded 2½ feet in concrete and are amply strong to sustain the hammock.

The fence on the side street is illustrated in Fig. 4. This view illustrates the means for securing the fence to the post by angle brackets of iron. The flower pots on top of the posts were molded from a regular 8-inch flower pot, and are made of cast iron, weighing 14 pounds each. The tops of the posts are threaded, and standard 3-inch caps are riveted to the bottoms of the flower pots, and they are then screwed onto the posts. This view also shows the back porch, the lattice of which is made from an elevator car. The posts of the back porch are made from 3-inch iron pipe, imbedded

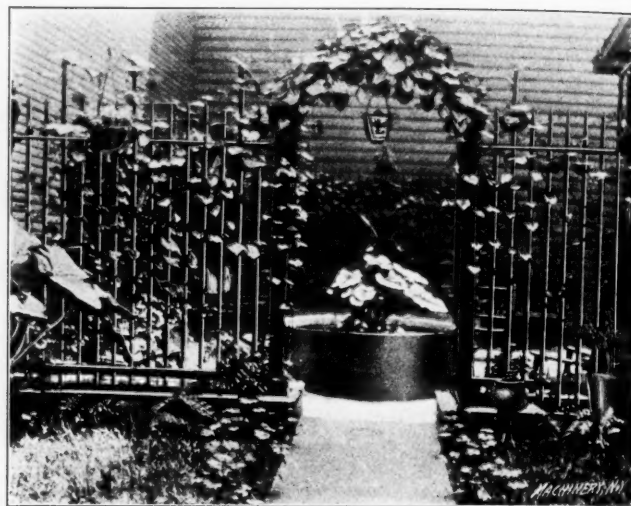


Fig. 2. Interior View of Yard showing Fish Pond in Center.

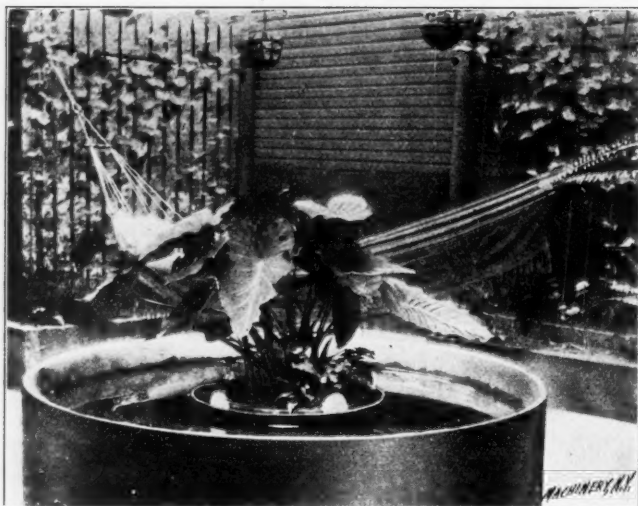


Fig. 3. Portion of Yard, with Fish Pond made from Cast Iron Pulley lined with Concrete.

Fig. 1 shows a front view of the yard and the ornamental fence and gates. The hinges of the gates have ball bearings. The lions' heads and scrolls are made of iron, copper plated with a verde green finish. In the yard are a sunken garden, concrete flower pots, hanging baskets, lamps, and a fish pond in the center.

Fig. 2 illustrates this portion of the yard and shows the fish pond, which is made from a 5½-foot diameter gas engine pulley, 24-inch face, and weighing 865 pounds. The interior is lined with concrete and faced with cement. The center of the pond, in which the plants are growing, is a discarded fire pot of a furnace, 24 inches diameter, 24 inches high, and weighing 245 pounds.

Fig. 3 shows a near view of the fish pond. This view also shows a fence used as a trellis for vines, and concrete flower beds 8 feet long, 15 inches wide, with 3-inch thick walls reinforced by iron wire woven and laid in the mold before the concrete is poured. The fence posts are 3-inch iron pipe,

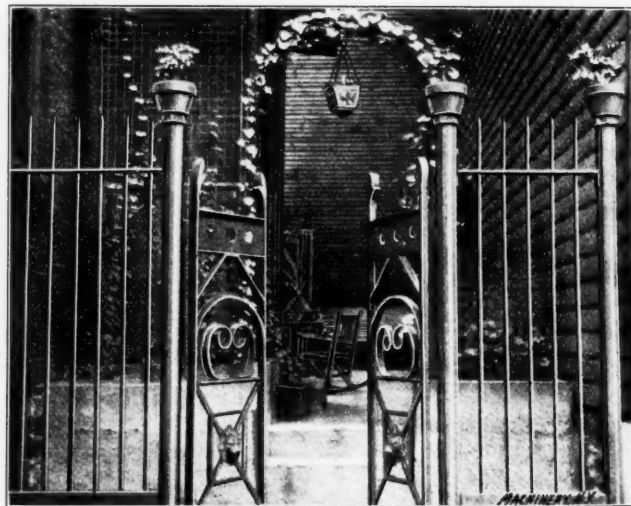


Fig. 4. Entrance from Side Street, showing Pipe Fence Posts and Cast Iron Flower Pots.

in concrete. The sliding elevator door was also utilized, and a lock is provided which secures the door and protects the refrigerator and contents which are stored in the porch. Pittsburg, Pa.

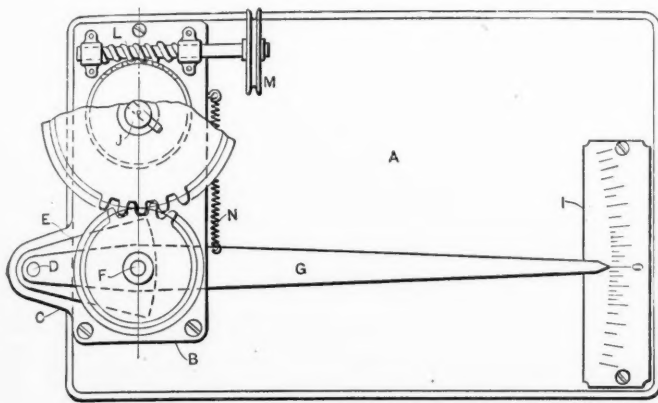
W. A. PAINTER.

### DEVICE FOR TESTING TRUTH OF CUT GEARS.

The illustration shows a device for testing the truth of cut gears used in the construction of gas and gasoline engines. All cut gears are tested after the machining is done, or if they are case-hardened, after the hardening process. Only gears that are absolutely true are put in the engines; however, a slight variation from truth will pass inspection. Gears that have been case-hardened will vary more or less, consequently a test must be made to see that no imperfect ones are used. In engines of this class, all gears are meshed closely to avoid any back-lash and to prevent as much as possible any noise in the running. If a pair of gears have become slightly oval in shape during the hardening process,

long and short diameters will exist which are not noticeable to the naked eye. Assembling gears of this kind will result in a "rattle" or a "bind" in each revolution, and to avoid such gears is the purpose of the test.

The device for making this test consists of a cast iron plate *A* ribbed at the bottom and machined on the top surface; a cast plate *B* with a projecting arm *C* in which is secured a shoulder stud-screw *D*; a cast-iron segment plate *E* drilled and reamed at one end to fit fulcrum stud *D*, and having at the opposite end a shoulder stud *F* on which revolves a master gear of the same pitch as the gears to be tested; an



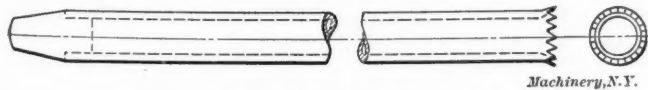
Testing the Truth of a Cut Gear by revolving it with Master Gear and noting changes in Center-to-center Distance.

indicator pointer *G* drilled to pass down over fulcrum stud *D* and axle stud *F*; a graduated brass plate *I* secured to base *A*; and a shaft *J*, the lower end of which revolves in a step bearing beneath the plate *B*. To this shaft is secured a worm-wheel, and on the part which projects above this worm-wheel are placed, and rigidly secured by means of a key, the gears to be tested. The worm *L* is made of machine steel and case-hardened, and is driven by a 1/2-inch round belt passing over wheel *M*. A steel spring *N* is fastened to plate *B* and index hand *G*. The segment plate *E* is machined on its bottom face which rests and slides on the upper face of plate *B*. On the upper face of plate *E* rests the index hand, and on top of this is a steel washer around axle stud *F*. On this washer rests the master gear, which is perfect in every detail. The gear to be tested is revolved by means of the wheel and worm, and any irregularity in the diameter will show on the graduated plate.

DETROIT.

### MAKING AND HARDENING A DRILL FOR BRICK.

The accompanying illustration shows a cheap and serviceable form of drill for brick walls, which can be made from wrought iron, gas or steam pipe. A solid plug is welded in one end to close it up and serve as a head for the drill, and the other end is serrated after the same manner as a hollow mill or core drill, and slightly spread to give it clearance. As the drill is made from wrought iron, ordinary methods of hardening are of little use; but by heating the working



Brick Drill made from Wrought Iron Pipe.

end of the drill to a fusing temperature, along with a piece of thin cast iron, and allowing them to come in contact while in the fire, part of the cast iron will adhere to the wrought iron and can be pretty evenly distributed over the teeth by turning the drill. After a fair coating of the cast iron has adhered to the teeth, remove the drill from the fire, shake it or give it a light rap upon something solid to remove any surplus cast iron, and insert in a cold water bath. The teeth of a drill treated in this manner are so hard that they can not be touched with a sharp file, and will wear until the rest of the drill is completely worn out if it is not subjected to heavy hammering.

JAMES CRAN.

Plainfield, N. J.

### CUTTING AN ACCURATE SCREW FROM AN INACCURATE LEAD-SCREW.

"We find, after testing, that the feed-screws of the machines supplied by you to our order are not accurate enough for our purpose; before placing any further orders with you we should like your assurance that this matter will receive your attention."

Thus ran an epistle received by us from one of our best customers, and one of the first things done after reading it was the testing of the lead-screw of our precision (?) screw-cutting lathe. It was found to be about 0.090 inch out in six feet, so that our customer had just cause for complaint. A conference of heads of departments was held, and various methods of overcoming the difficulty suggested. One idea was to have a threaded bush to take the thrust of the lead-screw, arranged so that as the lead-screw revolved the bush was also turned by suitable gearing, pulling the lead-screw and carriage bodily with it as it screwed out of its bearing. This scheme, though a good one, was vetoed because, as one of the foremen pointed out, it could only rectify the aggregate inaccuracy; local errors would not be provided for. I then had a turn, and claimed that I had a scheme whereby all local errors were rectified. The idea of all the local inaccuracies in the lead-screw being corrected in the screw being cut, was deemed impossible and at first sight it does seem to be a rather difficult thing to accomplish, but after an explanation of the proposed method it was acknowledged that the scheme was practicable. We did not use it, however, as it was thought advisable to install a new lathe, and with this machine we got a lead-screw which was guaranteed to be within certain limits; however, it might be interesting and useful to readers of *MACHINERY* to know how we proposed to

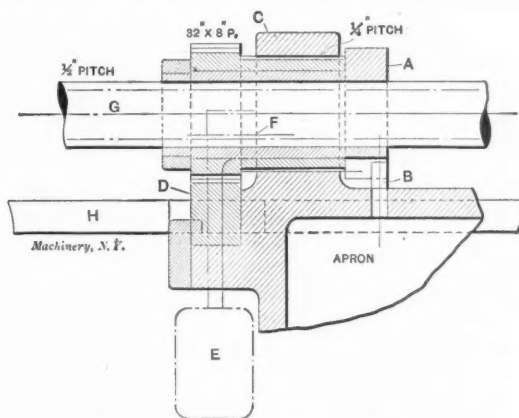


Fig. 1. Section in the Plane A-B, Fig. 2.

accomplish the seemingly impossible task of cutting an accurate screw from an inaccurate lead-screw.

The first thing to do is to measure the pitch of the lead-screw at a number of places, and find what the inaccuracy is. A large change gear is mounted at the end of the screw and, assuming that the lead-screw is 1/2 inch pitch, six turns of the change gear should move the carriage exactly 3 inches. Every 3 inches seems to be a convenient distance, though longer or shorter distances could be measured in exactly the same manner; of course, the lead-screw would have to be turned a larger or smaller amount. After the change gear has been revolved, we will say 6 times, a vernier or micrometer is used to measure the actual movement of the carriage. By this means we can tell how much the actual movement differs from the theoretical movement, or, in other words, how much the pitch of the screw is out. This difference or error, for every 3 inches of the whole length, is tabulated, care being taken to also record whether the pitch is large or small. When the screw has been measured throughout its length, the next operation is the correction of the errors. The method whereby this is done is shown diagrammatically in Figs. 1 and 2:

Referring to Fig 1, a special lead-screw nut *A* is screwed directly onto the lead-screw and kept from revolving by the pin *B*. On the outside of the nut revolves the 32 x 8 pitch gear, the shank of which is threaded externally and screwed into the bracket *C* which is screwed to the apron. Meshing

with the  $32 \times 8$  pitch gear, is a rack *D* upon the top of which presses the weighted lever *E* pivoted at *F*. At the lower end of the rack is fixed a runner *J*, as shown in Fig. 2. It will be seen that if rack *D* be moved either up or down the carriage will be moved independently of the lead-screw *G*, and a simple calculation will show that 0.050 inch movement of the rack will move the carriage 0.001 inch, so that if we can arrange some means of raising and lowering the rack at the right time and the right amount, we shall be able to cut a screw which will not be a copy of the lead-screw because it will not have its errors. At the front of the bed and directly under the runner on rack *D* is a fence-like structure *H* made

equal parts, and the points thus found projected onto the line *AB*. Radial lines *DE*, *DF*, etc., are then drawn from the center *D* through these points to the circle *AHGB*, transferring the harmonic motion to the path of the cam rollers. The arcs *OT*, *EU*, *FX*, etc., are then drawn. The outermost position of the cam roller with respect to the cam, will be seen at *A*, likewise the innermost at *O*. Arcs are drawn through these outer and inner positions of the roller centers. A distance *JS* is chosen, depending upon the time required for the action. This time must not be too long, else interference of the cam and rollers will result, and if too short, a sharp point at *O* is developed. *JS* is divided into the same number of

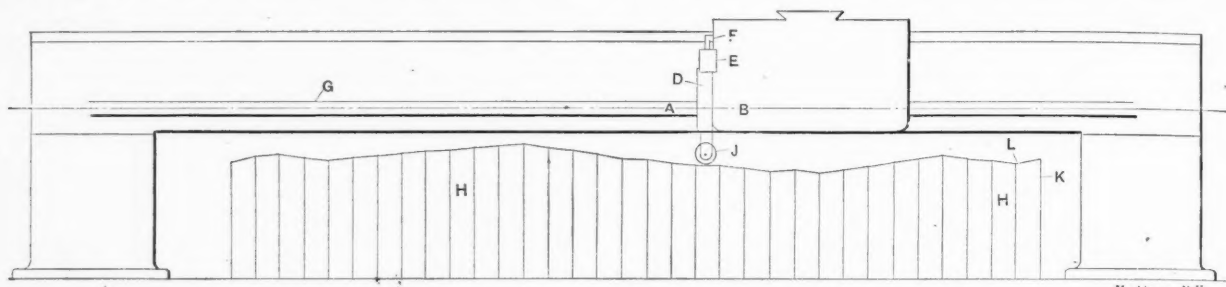


Fig. 2. Device for Correcting Inaccuracies in the Lead-screw by an Automatic Movement of the Carriage regulated by the Rise and Fall of Roller *J*.

of wood. This consists of a number of boards, joined together by battens at the back, and arranged so that the runner may work on the end of the grain of the wood. Knowing what the errors in the screw are, and also knowing that to raise or lower the rack 0.050 inch gives a carriage movement of 0.001 inch, it is quite an easy matter to reckon up how much the vertical movement of the rack must be to compensate for the errors we have previously tabulated; so that if we divide the board *H* into 3-inch spaces by vertical lines, we are in a position to mark out the profile required to meet our particular needs. Suppose that in the first 3 inches the pitch of the lead-screw was 0.003 inch short; we should know then that the fall between the first and second 3-inch marks *K* and *L* would require to be 0.150 inch. Proceeding in this manner, the whole of the profile is marked out. Then, if care is used in cutting to the marks and in mounting the board in position, we are ready to get to work on our screw, knowing that the errors in the lead-screw will be corrected by our automatic compensating gear. Of course, when cutting the corrected screw, the counter-shaft will have to be reversed, as the lead-screw nut must not be disengaged. I forgot to mention that it would, perhaps, be advisable to take the measurements of the lead-screw after the solid nut *A* has been put into position, as the conditions then would be more like the conditions when actually cutting the screw.

As mentioned before, we didn't have to operate on our old lathe, but if I am ever placed in similar circumstances, and a new machine is out of the question, I should have no hesitation in trying this method of making the inaccurate lead-screw cut one that is accurate.

RACQUET.

#### INTERMITTENT CAM-CAM ROLLERS.

The writer recently had occasion to give a shaft an intermittent motion with an angular movement of 90 degrees, the shaft to revolve in one direction and the power to be obtained from a parallel shaft having a speed ratio of 4 to 1. A pair of intermittent gears would have done the trick perfectly, but were not used as excessive shock was feared on account of the high speed to which they must be run.

On one end of the shaft to be rotated, a disk with four cam rollers *A* spaced to 90 degrees, was placed, and working over this plate was the cam *B*, as shown in Fig. 1. The development of this cam is shown in Fig. 2. Though originality is not claimed for the design, it may be of interest. The cam imparts the regular crank motion, as shown further on, and the action is, therefore, quiet and easy. To lay out the cam, a circle *AHGB* is chosen for the path of the cam rollers of the driven shaft, and divided into four parts. The cam action is to take place on the line *AB*, which line is perpendicular to the center line of the centers *M* and *D*. Upon *AB* the semi-circle *ACB* is drawn and divided into any number of

parts as the arc *CB*, and radial lines drawn to the center *M*. At the intersection of these lines and the arcs *OT*, *EU*, *FX*, etc., which have been previously drawn, we have the centers which the cam rollers must successively occupy. Three arcs are then approximated to cut these centers, giving the cam track desired. One-half only of the cam is shown developed, as the other side is symmetrical.

In order that the cam slot can engage the next roller, either a pawl must be used to hold the roller plate (using only the effective part of the cam by cutting away the dwell), or notches cut into the side of the cam itself to admit the next

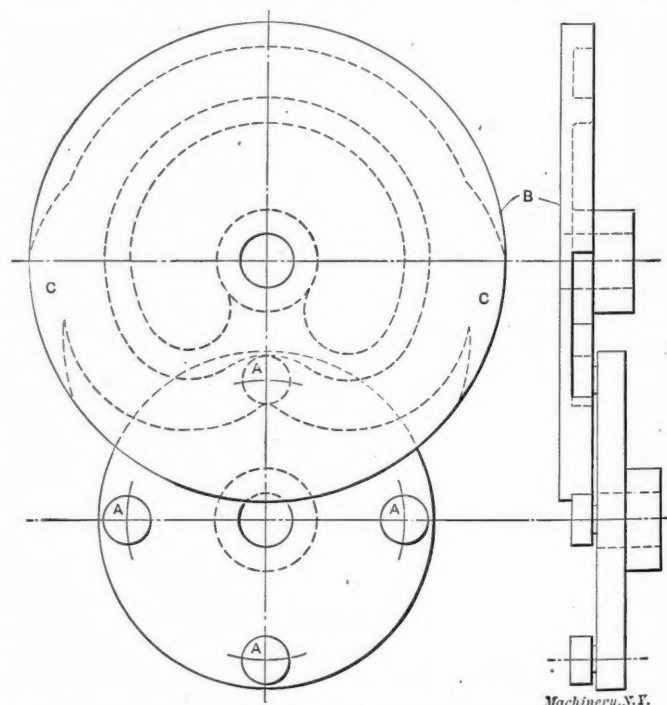


Fig. 1. Cam, and Disk with Rollers, by which an Intermittent Movement is Imparted to the Driven Shaft.

roller into the track. These notches *C*, Fig. 1, can be laid out at the time the motion is plotted, but the method used in this instance for determining the shape and position of the slot was a more natural one, as a lay-out of both cam and roller plate was made on cardboard and the parts cut out and pivoted on thumb tacks; then by revolving the disks, having previously blacked the rollers, the shape of the notch developed itself. It will be seen that two rollers are engaged in the track at the dwell of the cam, thus making a more rigid stop than is obtained with intermittent gears.

As a rule, cam rollers belie their name, in that they do not roll; they stick once, then a flat soon appears on the

periphery, or the stud wears thereby, destroying the true cam action. The ball bearing rollers shown in Figs. 3, 4 and 5, overcome these difficulties and from experience I know that these rollers roll, require little attention, and insure the true cam action being maintained. Fig. 3 is a somewhat heavy type, the two bearings being contained in a sleeve which protects them from dirt and dust. This roller has the

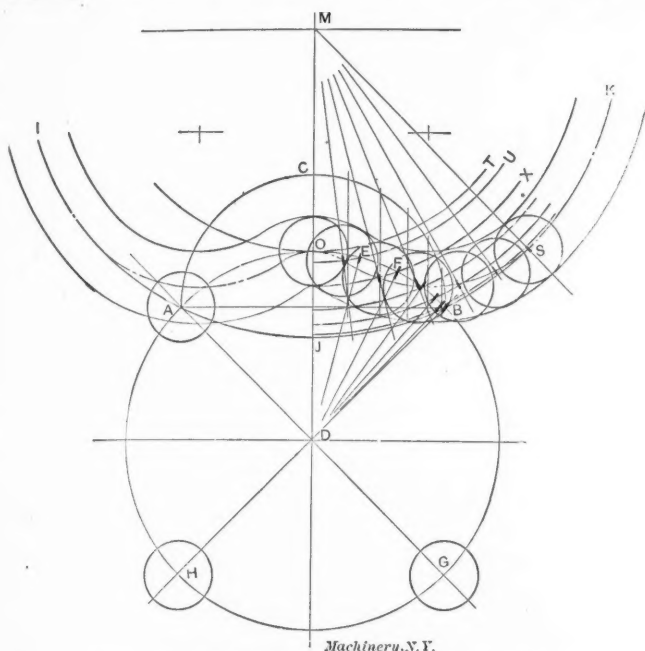
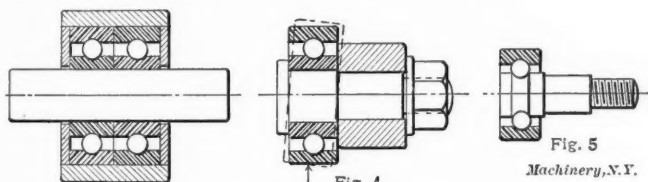


Fig. 2. The Development of the Cam shown in Fig. 1.

advantage of being supported from each side. The bearings used are an article of manufacture. Fig. 4 illustrates a roller designed to overhang its point of support. The cam arm should be rather heavy to keep the roller true, especially if designed for a movement that is heavy, or if at times subject to very quick action; otherwise the roller may cant a bit, as shown exaggerated by the dotted lines. This is a point that



Figs. 3, 4 and 5. Three Types of Ball-bearing Cam Rollers.

is often overlooked in the ordinary roller, and while it is desired to avoid this overhung style, at times this type is by far the most convenient. In Fig. 5 a light type of roller is shown. As this type is small, the design is changed slightly, the internal ball race being removed. As will be seen, this race is cut in the stud which holds the roller to the arm or plate.

CYRUS TAYLOR.

London, Eng.

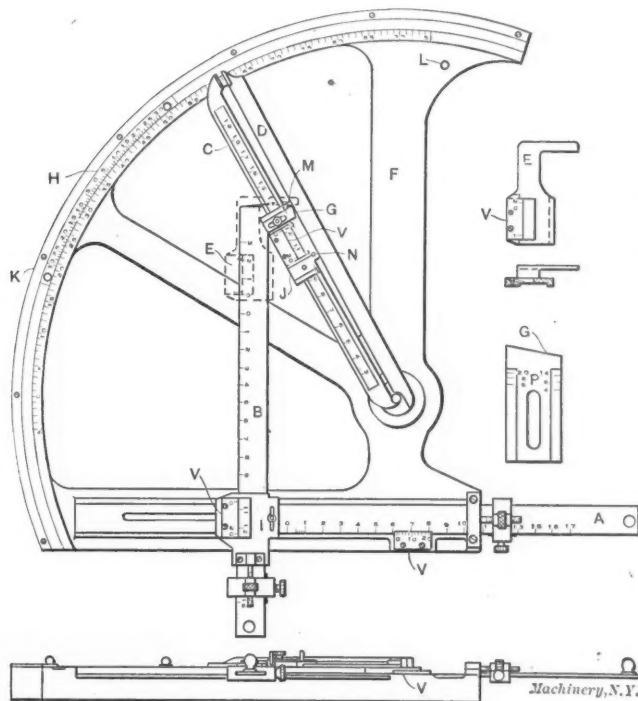
### A BEVEL GEAR GAGE.

In order to overcome the necessity of calculations for bevel gears, the gage illustrated in the accompanying engraving was constructed. The range of this gage will permit calculations of bevel gears from 1½-inch to 24-inch pitch diameter to be readily made. The frame *F* is a brass casting reinforced by ribs not shown in the engraving. It is finished and graduated on the rim to half degrees. The rim is also grooved to receive a vernier slide *H*, which reads to minutes. This slide is retained in place by the strip *K*, allowing the vernier to slide with slight friction. The lower part of the frame is planed to receive a scale *A* running in a groove with a good sliding fit. The head *I* is fastened tightly on the end of the scale *A* and forms a slide for the scale *B*. On the end of scale *B* is a small arm, not indicated, which carries a hardened bushing receiving the taper pin *M*. This latter is driven tightly into the slide *J* and its center is exactly on the radial line from the center of the arm *C*, and

the index at the arm's recording end is at the rim of frame *F*. The slide *J* is of a channel shape, sliding freely on the radial arm *C*, but can be lifted off the arm entirely. The scales were made to order by the Brown & Sharpe Mfg. Co., and are graduated to fiftieths of an inch. Each scale is provided with a vernier, reading to 0.001 inch.

Given this arrangement, it will be seen that if the scale *B* is slipped down until the zero mark on this scale is opposite the zero on the vernier at *V*, the radial arm *C* will be parallel to the scale *A*. In this position, scale *A*, scale *B*, and slide *J* can be moved as one piece in the longitudinal direction of scale *A*, the radial arm remaining at zero on the degree scale on the rim of the frame. When the scale *B* is moved from its zero, the arm *C* will register the angle accordingly. The arm *D* is called the face-angle arm, and is moved independently from arm *C*. It is provided with a hardened straight edge on a line exactly radial from the center where the arm is pivoted. This arm is used for determining the face angle and the depth of cut, as will be referred to later.

The piece shown in detail at *E* is the diameter increment gage, more commonly called the blank diameter gage. It is made to slide on scale *B* and is used only when face-angle arm *D* is moved away. At *G* is shown one of the addendum and depth of cut gages. These gages are shown in detail, so as to show more clearly the lines and figures by which they are graduated, the gage *G* being also enlarged. The addendum and depth of cut gages are hardened and ground to fit the slide across the top of slide *J*. Owing to the fact that the pitch lines would come too close together if all were marked on the same piece, there may be different blades for different pitches and depths of cut. One of these blades can be seen in place in the assembly drawing, with the corner extending beyond the center of the pin *M*. If the gear was a four-pitch gear, the amount of extension would be one-quarter inch; if a 6-pitch gear, 1/6 inch, etc. The blades are set by bringing the pitch lines opposite the zero mark on slide *J*. The gages can be used at either end of slide *J*, the point *N* becoming the working point when it is necessary to get



Gage facilitating Bevel Gear Calculations.

closer to the center for small bevel gears. When the gage is set, if the arm *D* is brought up against its point, the face angle is thereby determined.

As an example, we will assume that we are to make bevel gears like samples furnished us. We find in the larger bevel gear of the samples furnished 40 teeth, and in the smaller 20 teeth. The larger gear measures roughly about 10 inches pitch diameter, and we therefore decide that it must be 4-pitch. To get the correct size of the larger gear, set scale *B* to one-half the pitch diameter of the large gear, or 5 inches,

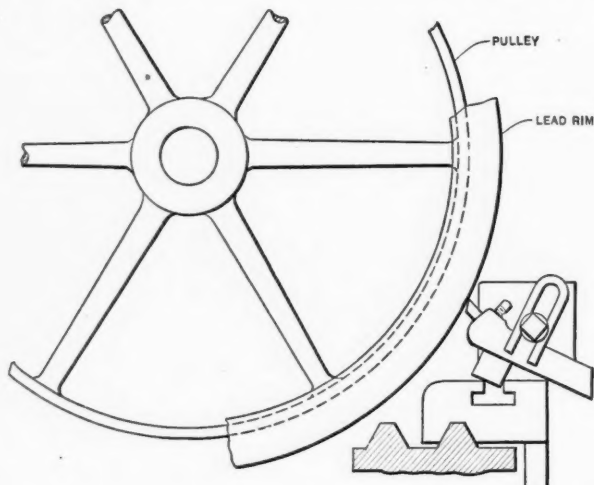
and set the scale *A* to one-half the pitch diameter of the small gear, or  $2\frac{1}{2}$  inches. Lock the scales by means of the wing nut on the head *I*. Take an addendum gage for 4-pitch, and set the 4-pitch mark in line with the zero on slide *J*. Bring the arm *D* up to the corner of the blade of the gage, and read off the angle to which it points on the protractor, using the vernier *H* if necessary. The angle read off the scale is the face angle of the blank. Now move the arm *D* around against the stop pin *L*, place gage *E* on scale *B* and slide it down until the extending arm touches the addendum gage on the corner. Then take the reading of the gage *E* at the vernier. Twice the amount of this reading, plus the reading at the *B* scale vernier, equals the outside diameter of the blank. This whole operation is done in less than five minutes. It simplifies the method of getting the sizes of bevel gear blanks, and particularly for the repair shop, is a great convenience.

The gage may also be used as a right angle triangle computer. Scales *A* and *B* may be considered as the sides including the right angle, and the scale on the arm *C* will give the length of the hypotenuse, registering one of the oblique angles on the protractor at the same time. By setting the slide *J* to a unit radius and the arm *C* to a known angle, the reading on scales *B* and *A* becomes the sine and cosine, respectively. By setting scale *A* to a unit length and arm *C* to a known angle, the reading on scale *B* becomes the tangent of the angle, etc.

W. A.

### GRINDING WHEEL FOR LEATHER SPLITTING KNIVES.

From a mechanical standpoint, the most exacting as well as the most interesting process in the manufacture of fine leather is the cutting of the tanned hide into thin sheets or "splits," which are worked up into a multitude of products, ranging from watch fobs to automobile cushions, and varying in thickness according to their respective uses. As the allowable deviation is but a few thousandths inch, the splitting



Machinery, N.Y.

Turning a Large Pulley with Lead Rim in a Small Lathe.

machine must be kept in perfect condition, and the cutting knife be maintained with almost a razor-like sharpness to prevent dragging or crowding the hide and leaving a thick spot. There are two types of splitting machines in general use, one of which has a cutting knife  $\frac{3}{8}$  inch thick, 4 inches wide, and about 6 feet long. This knife is sharpened at the top and bottom, with the ground edges extending back nearly 2 inches, forming as sharp an angle as is practicable. The grinding is done with fine, sharp sand applied to a lead wheel, across the face of which the knife is passed.

One of the "annual" jobs is the preparation of a new grinding wheel. A 24-inch pulley with a number of one-inch holes drilled in the rim is put in a sand mold and lead poured in, completely surrounding the rim. The pulley is then turned off to a diameter of 27 inches and the edges chamfered. Our largest lathe will not permit the tool-post to pass the pulley, so we used first a tool that extended out 7 inches which, though made of heavy stock, left fine chatter marks. Before the chips fell from the tool, they would also rub against the

finished surface, and produce straggling grooves. The wheel as finished, though passable, did not present a neat appearance, so I decided to have it done in another way, as shown in the illustration. An angle plate was bolted to the lathe carriage, and to it was clamped the tool suitably blocked. In this position the tool is rigid, and its slant is sufficient to let gravity carry the chips away, and the completed wheel is perfect. It might be asked why such a wheel is used in place of an ordinary abrasive stone of proper grade. There are two reasons: First, in order to have the cutting edges of the knife as little concave as possible, a large grindstone wheel must be used, the cost of which does not compare favorably with the lead wheel method; second, the lead and sand method heats less, leaves less "feather," and a better edge than other wheels that have been tried for the purpose.

Middletown, N. Y.

DONALD A. HAMPSON.

### SPECIAL HOB FOR WORM-GEARS.

The accompanying half-tone and line engraving show a hob made by the writer several years ago for facilitating the cutting of worm-gears. It is well known that if a hob is not provided with relieved teeth, it is an unsatisfactory

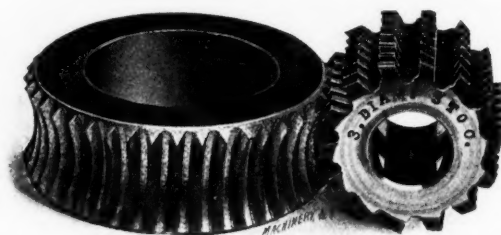
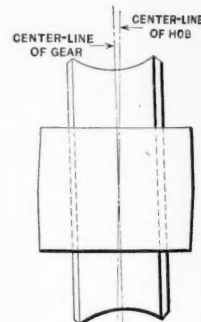


Fig. 1. Worm-gear and Special Hob by which it is Cut.

tool for removing stock, and can only be used for the last finishing touches on the worm-gear after it has been previously gashed. The gears which were to be cut in this case were commonly made of cast iron, and to first gash these worm-gears and then hob them was rather expensive. There were no facilities for making ordinary hobs with relieved teeth, but there was a lathe in the shop fitted with a relieving attachment whereby it was possible to relieve single cutters. In order to overcome the necessity of using hobs with relieved teeth, we proceeded to make a special form of hob, as shown in the accompanying half-tone and line engraving. On this hob, teeth were cut of the same form as the cross-section of the worm thread, but instead of giving a lead to the hob thread, the teeth are simply circular ridges around the tool, and the threads are circular grooves. The hob is then fluted in the ordinary way. When in use, the hob or cutter, as it would be more properly called, is set at an angle with the axis of the worm-wheel in order to produce the proper angle of the teeth in the latter. The outside of the hob is turned to a conical shape toward each end, the cutter being full size in the center, and the angle of the taper being equal to the angle to which the cutter is turned or rotated for cutting the worm-teeth. This angle, of course, is the same as the angle to which the saddle of the milling machine is turned when hobbing. When using this tool for hobbing, instead of indexing one tooth at a time, it is common to index around a number of teeth at a time, so as to give the cutter a chance to cut nearly an equal amount on both sides of the center. This obviates any tendency of crowding caused by a heavier cut on one side than on the other. Finally, of course, the worm-gear is finished by indexing one tooth at a time.

It should be stated here that originally there was no thought of making the gears without hobbing, but it was found that it was possible with a cutter of this form to cut



Machinery, N.Y.

Fig. 2. Diagram illustrating the Setting of the Hob.

a fairly good-looking gear without hobbing. Of course, the gear will not be theoretically correct, but it will be nearly enough correct for the commercial purposes for which it is intended. It is evident that both right-hand and left-hand cutters can be cut simply by turning the table on which the index centers with the worm-wheel are mounted, in opposite directions.

FRANCIS P. HAVENS.

Waltham, Mass.

### TURNING SOFT RUBBER.

In the How and Why column of the December issue of MACHINERY a question regarding the turning of soft rubber was submitted. The writer has turned soft rubber with an ordinary wood-turner's gouge, about  $\frac{1}{2}$  inch wide, and it works very well. The gouge must be ground hollow and kept very sharp. The shavings resemble band rubber. No lubricant is used.

F. A. ROSS.

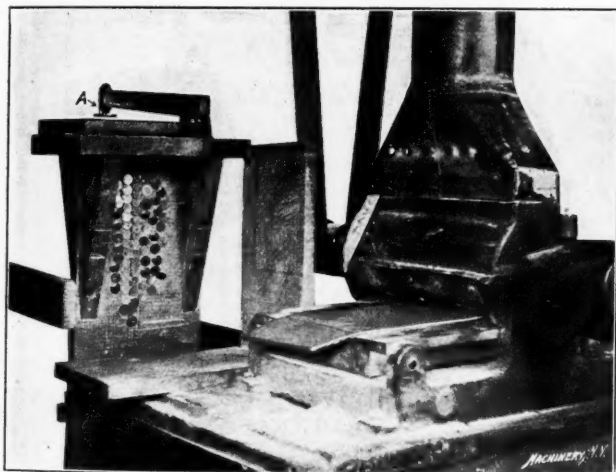
Beloit, Wis.

In regard to "L. M.'s" question as to a method of turning soft rubber in a lathe, the following procedure will be found to give good results. Rig a small grinding wheel on the tool-post, driven by a drum from overhead or by a small motor attached to the carriage. If a grinder of suitable size is available, more accurate results will be obtained. This is the method used for turning the soft rubber couch rolls used on paper machines. No lubricant is necessary.

Bay City, Mich.

H. J. MASTENBROOK.

In reply to the question submitted by "L. M." in the How and Why section of the December issue of MACHINERY as to the best method for turning soft rubber, the writer would suggest the use of an abrasive wheel. It would be well to write to one of the large firms making such wheels, stating plainly the kind of rubber to be turned; in this way exactly the right kind of wheel for the purpose can be obtained. The lathe should then be rigged up for exactly the speed recommended by the wheel makers. It is important that the correct speed be employed, as a difference of a few hundred revolutions



Machine for Grinding Soft Rubber Sheets to Correct Thickness.

per minute may cause difficulties. If a grinder is at hand, it is, of course, better to use this machine than to rig up a lathe for the purpose.

The accompanying half-tone shows a grinder used in a rubber stamp factory for obtaining a uniform thickness of thin sheets of vulcanized soft rubber which is provided with letters on one side. Such a sheet is shown in the front of the enclosed emery wheel. The dust is carried off through a hood by the suction of a fan. A gage for showing the thickness of the sheets in thousandths of an inch is shown at A. While the grinder shown is not likely to be one that "L. M." could use, it illustrates the principle of the only satisfactory way of machining soft vulcanized rubber—that is, by grinding.

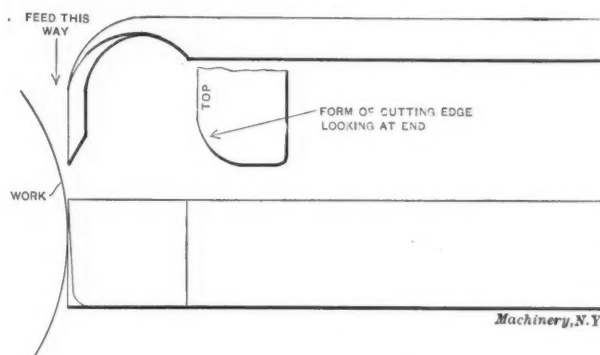
ETHAN VIAL.

Decatur, Ill.

In the December issue of MACHINERY, "L. M." asks for information about turning soft rubber. The writer submits a

little of his own experience which may be of service as an answer.

Provide first a tool of almost razor-like keenness; then, rubber-turning is practically a repetition of similar work on other soft materials run at a high speed. Fig. 1 shows a rubber turning tool used for feeding from right to left, with the



Machinery, N.Y.

Fig. 1. Tool for Turning Soft Rubber.

point ahead. The noticeable feature about it, distinguishing it from other turning tools, is its lack of clearance. The elasticity of rubber renders clearance unnecessary; in fact, it is objectionable. The tool shown is set above center, and the lower side of the cutting point is flared out to give stiffness to it. A tool to cut when feeding in either direction is made with a double cutting point like the section in Fig. 2.

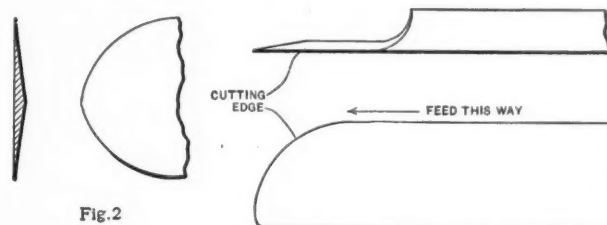


Fig. 2

Fig. 3 Machinery, N.Y.

Fig. 2. Double-edged Tool for Turning Soft Rubber. Fig. 3. Cutting-off Tool for Soft Rubber.

On one occasion some rubber compression springs for file cutting machines were finished. The stock came in "bars," three inches in diameter, with a one-half inch core running through the center. The pieces were cut off on a bandsaw to approximate length, and then faced off in the chuck with the tool shown in Fig. 3.

For blanking out stock, round or otherwise, a bandsaw is quicker than any other method, but the operator should use great care or provide himself with suitable guides or clamps to prevent personal injury through the work catching and the latent spring in the rubber knocking the hands against the saw.

Contrary to the kink which so many know of wetting a knife before cutting rubber, the writer found it best to work it dry. The "dust" from the cut and the surfaces over which the tool passes will have a brownish hue—much darker than the stock as it regularly comes; to restore to the original gray or to remove finger marks, rub it on powdered soapstone in the lathe after the cut surfaces have been smoothed with sandpaper.

DONALD A. HAMPSON.

Middletown, N. Y.

### SAWING CAST IRON UNDER WATER.

Regarding the question in the How and Why section of the December issue submitted by the "H. M." Co., the writer would say that if it is necessary to saw cast iron under water, a coarse-toothed saw should be used to minimize clogging, and some form of positive feed employed to force the saw into the cut. If the saw fails to cut for even one forward stroke, wet cast iron will tend to glaze, no matter whether the slip is caused by clogged teeth or insufficient pressure. Dull or clogged teeth will soon polish the slot so that even a new saw will not cut. The same tendency to glaze is noticeable in filing or drilling wet cast iron, and it is necessary to keep the tool constantly cutting and not permit it to slip. The same condition is met with in drilling unannealed tool steel.

If the cutting of cast iron under water is undertaken with the idea of obtaining more speed, the procedure is inadvisable for obtaining the object desired. If speed in cutting is wanted, a metal-cutting bandsaw will give the best results.

Decatur, Ill.

ETHAN VIAL.

DRILLING HOLES IN GLASS.

Many people think that it is a very hard job to drill holes in glass, but this is not so. It requires, of course, more time and more care than drilling in metal, because there is greater danger of breaking the glass.

The drill is made of a steel rod or an old three-cornered file. One of its ends is ground to a long tapering triangle-shaped point. It is placed in a swiftly revolving chuck (lathe or electric hand drilling machine), and the glass pressed against it very gently.

The work should be held in the hands in order to feel the pressure against the drill. As a lubricant, turpentine is used.

North Tarrytown, N. Y.

JOHN INGBERG.

SLIDE RULE FOR ADDITION AND SUBTRACTION OF FRACTIONS.

The slide rule illustrated herewith, will undoubtedly meet with great favor among draftsmen and engineers in general, who have occasion to check up long lists of dimensions on drawings. This operation can be performed with speed and perfect accuracy, all chances of error are entirely eliminated, and such work becomes a pleasure instead of a task by the aid of this simple slide rule which any draftsman can make in a few hours. Of course, it is understood, in performing operations in addition or subtraction on this rule, that the operator has a pencil and pad to keep account of the units and whole numbers.

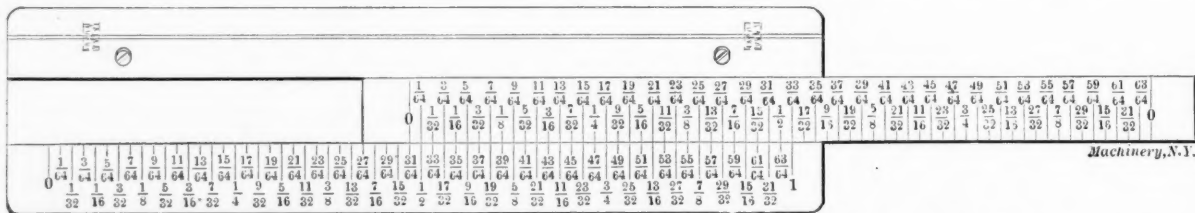


Fig. 1. Slide Rule set to add 31/64 to any of the Fractions on the Runner up to and including 33/64.

Assume that we wish to add 31/64 to 13/32: First set the left-hand zero mark of the runner to 31/64 on the lower scale, as shown in Fig. 1, and opposite 13/32 on the upper scale (or runner) read 57/64 on the lower scale for the answer. Assume that we wish to add 539/64 to 1647/64: First write down 21 on the pad, then set the right-hand zero mark of the runner to 47/64 on the lower scale, and opposite 39/64 on the upper scale (or runner) read 111/32 on the lower scale for the answer. This added to 21 = 22 11/32 for the final answer. Assume that we wish to subtract 51/64 from 15/8: First set

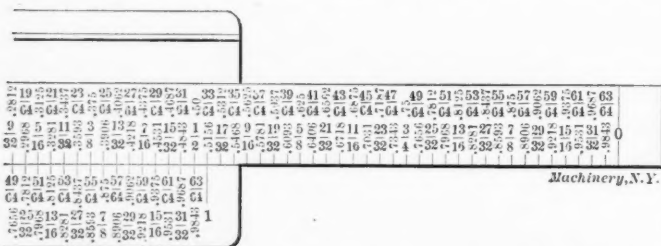


Fig. 2. Slide Rule illustrated in Fig. 1 with Decimal Equivalents Added.

the right-hand zero mark of the runner to 51/64 on the lower scale, and opposite 15/8 on the lower scale read 53/64 on the upper scale (or runner) for the answer.

The operations for addition on this rule are identical with those for multiplication on the ordinary slide rule, only the latter employs a logarithmic scale instead of scales of equal parts.

WM. C. MICHAEL.

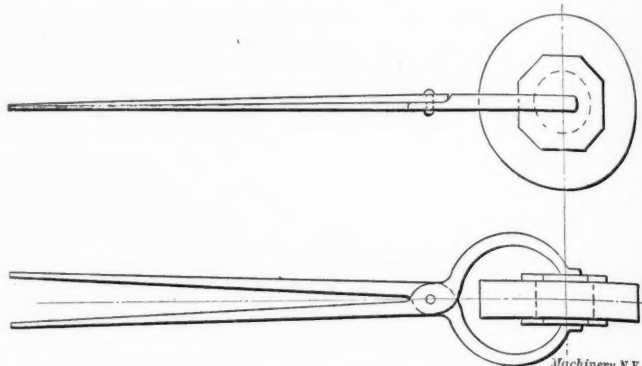
Claremont, N. H.

[The addition of the decimal equivalents of fractions to the slide rule, as indicated in Fig. 2, would increase its value considerably, though there might be some confusion because of

the multiplicity of numbers. The decimal equivalents would make it possible to add decimals and common fractions without changing the form of either, and the rule could also be used for checking drawings dimensioned with decimals.—EDITOR.]

REDUCING THE SIZE OF HOLES IN PARTLY FINISHED WORK.

In rough boring solid steel gears and similar work, it sometimes happens that the hole is made a little too large to permit a finishing cut to be taken. This may be done ac-



Method of holding Protective Shield over the Center of the Heated Piece.

cidentally or through carelessness on the part of the workman, but, in any case, the bored piece is useless for the purpose for which it was intended unless the size of the hole can be reduced. The easiest way to do this is to heat the piece to an even temperature, and cover each end of the hole with a shield of some kind; sheet asbestos placed under iron plates, or two pieces of wood, one on each side, can be used.

The covers are held in place with a pair of tongs as shown in the accompanying illustration. The work and covering is now plunged in a bath of cold water. The shields protect the center from the water. As all the cooling is done from the outside, the hot stock is forced toward the center as the outside shrinks. When fairly well cooled off, remove the piece from the bath and anneal it all over. The piece is then ready for the inside finishing cut.

Plainfield, N. J.

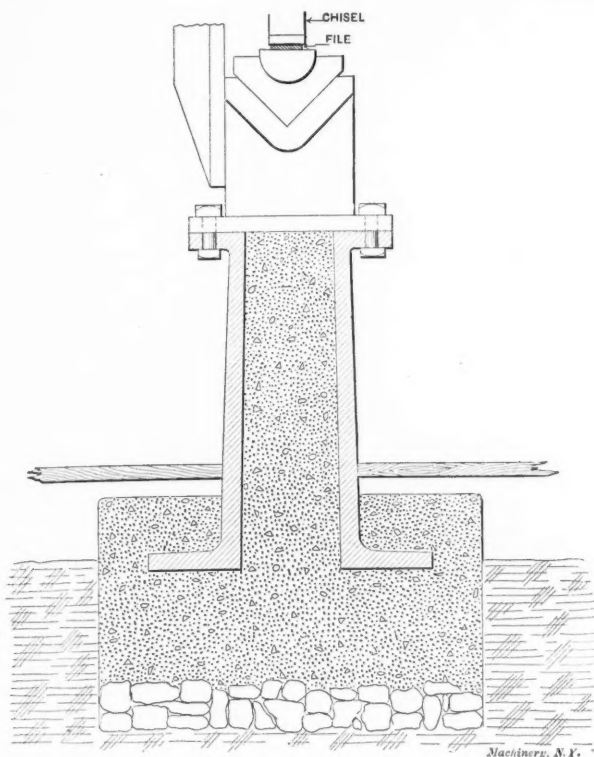
JAMES CRAN.

BASE AND FOUNDATION OF FILE CUTTING MACHINES.

In the manufacture of files, after the more preliminary operations, such as forging, annealing, grinding, and stripping, have been performed, the blanks go to the cutting shop where the teeth are formed on special machines. The blanks are held on a composition metal bed set in the table, which latter is driven longitudinally by a screw at a rate proportionate to the grade of the cut, and the teeth are cut thereon by rapid blows from a chisel secured in a holder or the chisel head. This chisel head or hammer, as it is commonly called, weighs, complete, from 8 to 12 pounds and makes from 2,000 to 3,000 strokes per minute. The machines for this purpose, subjected as they are to this constant jarring, should be well built and firmly mounted, not only to insure long life on their part, but also to enable the operator to turn out the best class of work; he must follow the cut with his eye so as to detect and immediately rectify any irregularity in the cut. A bench or a pedestal resting on the wood floor, found in some factories, will not answer for a foundation.

Some file cutting machines constructed by the writer were mounted as shown in the accompanying line engraving. The

foundation was built in the usual manner, the pedestal with the top perfectly level being supported from the floor until the concrete had set. In this case the pedestal was an octagonal casting, though a round or square one would have served quite as well. It will be noticed that as an aid to



Cross-section of a File Cutting Machine Concrete Foundation.

greater stability the inside of the pedestal is filled with concrete up to the base of the machine proper. As built, the foundations give perfect satisfaction.

Middletown, N. Y.

DONALD A. HAMPSON.

### BENDING DIE.

The die herein treated was designed and made for the third and last bending operation on the piece shown at A in Fig. 1. The metal is 1/16 inch thick, of soft composition, and easy to bend. The first and second operations are performed in a like number of dies; the blanking or cutting from strip stock being done in one die, and the bending of the blank to a U-shape, as shown at B, in another. No description of these tools will be given here as they are of simple construction and readily understood by the average tool-maker who is at all familiar with die designing and die making.

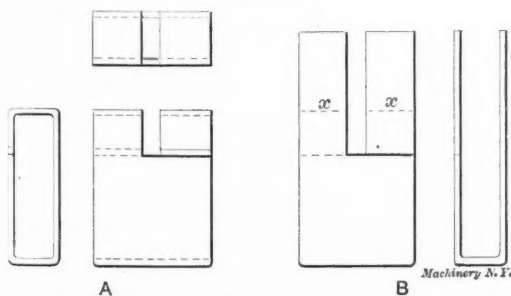


Fig. 1. Appearance of the Work when Finished and before the final Bending Operation.

The tool under consideration shown in Fig. 2, has, of necessity, several moveable parts in order to make the four bends required to complete the work. All the members are of simple outline and easy to make and assemble; therefore no detailed description of the methods of machining each part will be given. The holder A is of cast iron and is machined on the bottom, top, and sides to receive the several steel parts. The bending slides B and B are located in finished seats in the holder and secured in place by plates 1/4 inch thick, each of which is, in turn, fastened by four 5/16-inch countersunk screws. The slides B have a close running fit,

and are forced in to make the right and left bends by the cams K on the punch; their opposite or outward movements are made to take place by four compression springs C, located in the holder and acting against the pins D which are tightly driven into slides B. The third slide E, which has slotted holes to allow it to move in and out a limited distance, begins to operate after the other two have done their work; the object of this latter slide is to hold the steel form F, upon which the work is mounted, down, and free the formed piece from the punch on the up stroke. Springs hooked to the right-hand end of the press bolster and to pins J, return the slide E when the ram ascends. The four steel pieces H are adjusted, when the die is first set up in the press, to properly locate the form F which holds the work. The hardened rectangular steel piece K gives bottom to the work when in place to be formed. Hardened steel pieces L and L support the punch parts K and prevent their spreading when acting on the bending slides B.

The work having been bent U-shape previous to the finishing operation, is put on the former F which it pinches sufficiently to hold its own weight, and is carried to the die. On the down stroke the punch parts engage the inclined faces of the bending slides B and force them in, causing the right and left horizontal bends to be made at points indicated by the dotted lines x in Fig. 1. Further downward movement of the press ram permits these two slides to move out. The cam L forces the slide E inward until the inner ends extend

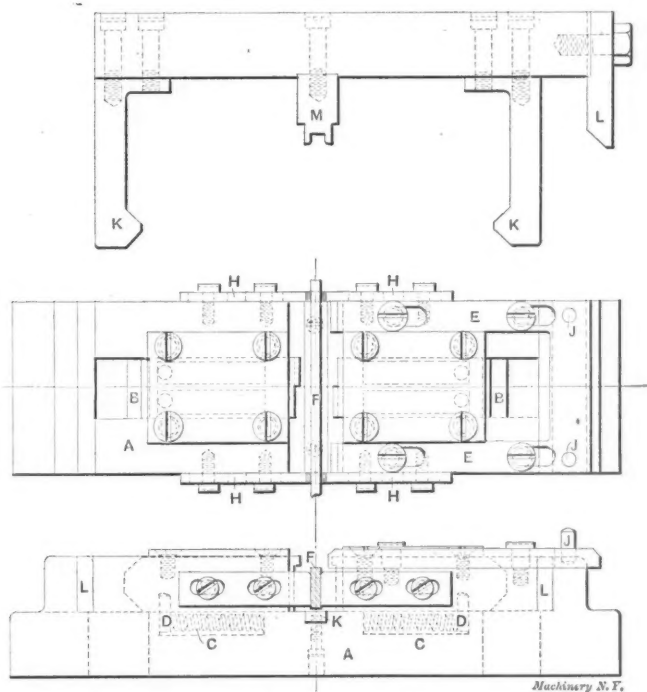


Fig. 2. Elevation and Plan of the Bending Die, and Elevation of the Punch, which form the Piece shown in Fig. 1.

over the bending form F, holding it down until the final bends are made by the former M, and the punch ascends sufficiently to free itself of the work. As the press slide continues to go up, the bending slides B make another in-and-out movement, thereby striking the formed piece a second time and setting the bends. The finished work is removed from the form by dropping the latter in a yoke secured to the press in a convenient position, and giving a slight pull. We have found it a good plan to taper the forms slightly from the section where the work is located, to the rear, to facilitate the removal of any material, after it is bent, that has a tendency to hug and not spring away. A suitable handle should be on the front end of the form for the comfort and convenience of the press-man, and it should extend to the front of the die sufficiently to make it absolutely unnecessary for the operator to incur any danger of accident by putting his hands between the working parts of the tool. We usually run this type of die in the press at about 100 strokes per minute, and have a slide movement of three or four inches. Several sizes have been made and all are giving good satisfaction. The tool herein described is of medium capacity.

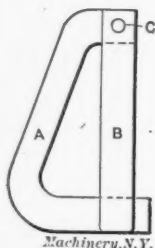
ENGINEER.

## SHOP KINKS.

## PRACTICAL IDEAS FOR THE SHOP AND DRAFTING-ROOM.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

## ADJUSTABLE ERASING SHIELD.



Machinery, N.Y.

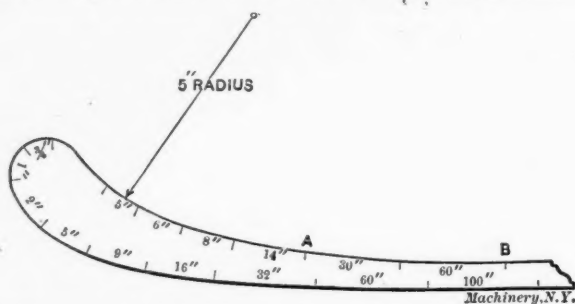
The engraving represents an adjustable erasing shield. It consists of two parts, A and B, which are hinged at C. By moving arm B, any size space can be had. Its advantage over the ordinary shield is that a very narrow space can be had at any time, while with the ordinary kind the spaces grow larger each time it is used. The shield is made of thin sheet brass.

Aurora, Ill.

JOHN B. SPERRY.

## DRAFTSMAN'S GRADUATED CURVE.

The use of curves in the drafting-room has become almost as necessary as the use of the angles. While their use may facilitate the drawing and designing of shapes of irregular curves, it often puts the pattern-maker to more or less trouble in producing the exact forms in wood. A drawing without di-



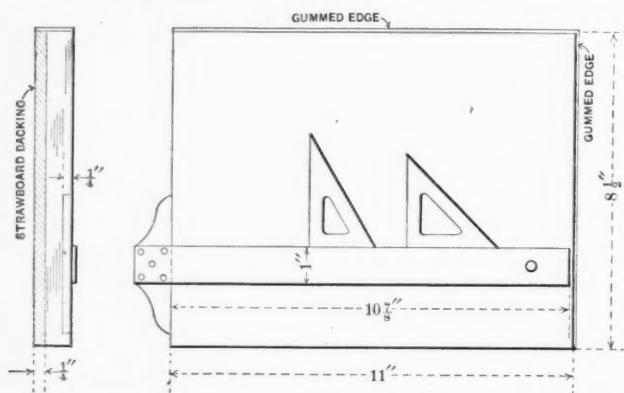
Machinery, N.Y.

mensions is of but little use to the workman; the same may be said of many outlines that are laid out in the manner mentioned. In most cases approximate outlines are good enough, but for particular exactness the radii should be given; and they can be obtained directly if the curve is graduated as the one shown above.

WINMAC.

## SKETCH PAD ARRANGEMENT.

The accompanying engraving shows a very satisfactory scheme for saving time and making accurate sketches without the necessity of hunting for a drafting board and thumb-tacks. Ordinary letter paper, or paper with a business heading, is blocked on an extra thick straw-board back, which should be at least 3/16 inch thick. The top and right-hand edges of the pad are gummed to hold the paper absolutely true. A small-sized T-square with a head no thicker than



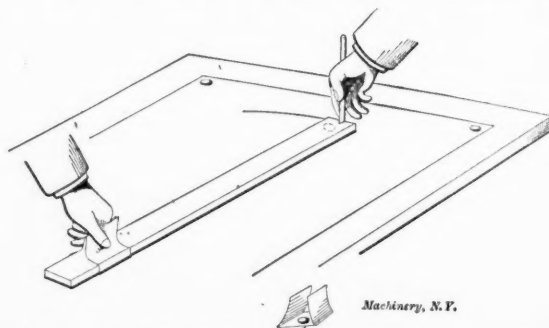
Machinery, N.Y.

the straw-board backing, and the blade about 1 inch wide and slightly shorter than the length of the pad, is used. This combination gives a simple and compact means of making small sketches, and is always ready. Its great advantage lies in the fact that it can be kept on the desk or slipped into a drawer, and takes up but little room. If a carbon copy is desired, one side of the top sheet can be loosened, and the carbon paper easily placed in position.

C. C. M.

## DRAFTSMAN'S TRAMMEL SUBSTITUTE.

Occasionally circles or arcs of large radii are required when a trammel is not at hand. Substitutes, which are more or less clumsy and impractically contrived and which are intended to give relief in such emergencies, are, at times, described in the mechanical magazines. The accompanying engraving illustrates an arrangement which, with proper manipulation, is capable of producing results equally as good as those obtained with the most expensive instrument, and it has the added advantage that the necessary materials



Machinery, N.Y.

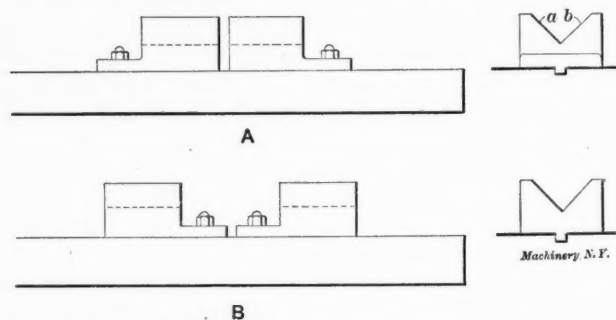
are always at hand with a moment's preparation. A straight-edge is provided with a small notch in one end and a thumb-tack, as shown by the dotted lines, inserted near it. A postal card having a thumb-tack point projecting from its center is creased over the stick; then the device is ready for use. Lay off the required radius on the paper and prick the center; insert the tack point and grasp the card flaps firmly with one hand while the other guides the pen or pencil in the notch as the curve is struck. The head of the thumb-tack which is near the notch, acts as a shoe which glides smoothly over the paper, and prevents blurring in case ink is used. A little practice makes the adjustment of the notch over the radius extremity a simple matter.

W. F. MOODY.

Denver, Colo.

## PLANING ACCURATE V-BLOCKS.

In planing a pair of V-blocks that are to be used on the planer platen for heavy keyway work, etc., the following method will be found to be a most accurate one, and the style of cast iron V-blocks, shown in the engraving, extremely well adapted for general use. First, the castings are planed on the bottom and the tongue made to fit the slot in the platen on which they are to be used, and, as there are various



Machinery, N.Y.

sizes of slots in planer platens, it is necessary that the succeeding operations be done upon the planer that the V-blocks are being made for.

After being drilled for the bolts, the blocks are placed on the platen as shown at A, and the tool-head is set to an angle of 45 degrees. A roughing cut is taken down side a, then the blocks are reversed as shown at B, and another roughing cut taken down the opposite side b. The foregoing operations are then repeated for the finishing cut, without disturbing the angular setting of the tool-head.

If this method is adopted for planing V-blocks, the user will find that the V is always in the center of the slot, regardless of the position of the blocks; but if they are planed by the old method of setting the tool-head first to one side and then the other, the V-blocks are only in line when set in slots as originally planed, and the workman, especially if he is a new one, is liable to get them placed the wrong way about, resulting in error and delay.

R. S. F.

## NEW MACHINERY AND TOOLS.

### A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP.

#### WHITCOMB-BLAISDELL SINGLE-SPEED PULLEY, GEAR-DRIVEN LATHE.

We present herewith a complete description with illustrations of a new 18-inch lathe, built by the Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass. This lathe is of the single-speed pulley type with speed changes obtained through geared connections. The principal feature of the design is the new form of clutch used in making the speed changes. This is of very ingenious construction, and involves a principle on which the builders have obtained a basic patent, though the idea is so simple that it is strange no one has previously patented it. Besides this one particularly novel feature, there are so many

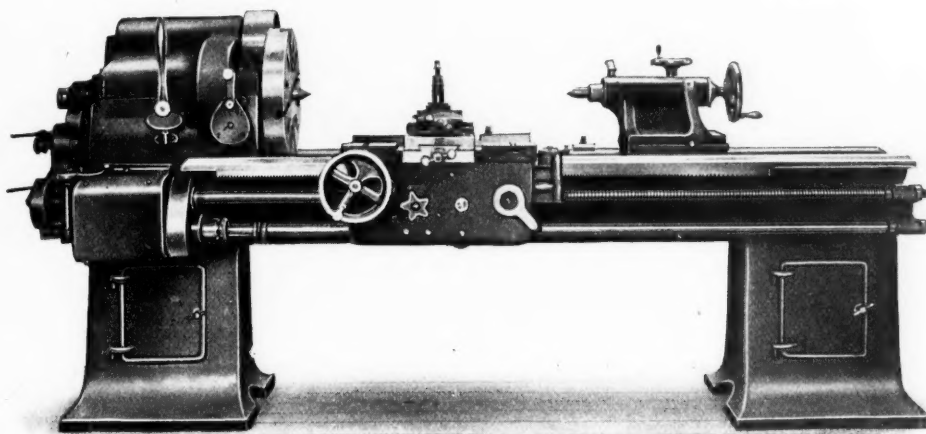


Fig. 1. The Whitcomb-Blaisdell Single-speed Pulley, Gear-driven Lathe, 18-inch Swing.

other points of originality in the design that the amount of space we have allowed for describing it is fully justified.

#### Driving Mechanism.

The geared head-stock is shown in elevation and detail in Figs. 1, 2, 3 and 5. Power is received at the driving pulley A (see Fig. 3), which is keyed to shaft B. This shaft revolves in fixed bearings in the head-stock and carries pinions  $C_1$ ,  $C_2$  and  $C_3$  keyed to it, and has pinion teeth cut on it at  $C_4$ . These four pinions mesh with corresponding gears  $D_1$ ,  $D_2$ ,  $D_3$ ,  $D_4$ , which normally revolve loosely on friction shaft E. Either one of clutch bodies  $F_1$ ,  $F_2$  and  $F_3$ , and gear H, may, however, be engaged with the corresponding gear  $D_1$ , etc., by means of clutches G, etc., whose construction will be described later. It is thus seen that four rates of speed may be given to shaft E when pulley A is running at constant speed.

Shaft E carries gear H keyed to it, and has pinion teeth cut in it at J. H and J mesh with gears K and L; K is keyed to clutch member M. L and M may be connected by clutches  $N_1$  and  $N_2$  respectively, with clutch bodies  $O_1$  and  $O_2$ , which are keyed to the spindle P. The four speeds, which may be given shaft E are thus doubled, giving eight speeds for the spindle.

The construction of clutches G and N—the main point of interest in this drive—is best seen in the detailed views at the right of Fig. 3. The peculiarity of this form of clutch may be expressed by saying that it is a positive friction clutch—that is to say, its engagement takes a measurable amount of time and allows some slipping of the engagement surfaces, thus obviating the severe shock met with at high speeds in positive clutches. On the other hand, it avoids the uncertain driving power and excessive slippage met with in friction clutches, and obviates as well, the necessity for frequent or even occasional adjustment.

In the upper clutch, the expansion ring  $Q_1$  is hung on a pin  $R_1$ , which is, in turn, fast to the revolving gear  $D_1$ . This ring is thus always rotating when the driving pulley is in motion. The open end of ring  $Q_1$  has pivoted to it a lever  $S_1$ , which through the medium of strut  $T_1$  may be made to spread the ring open, engaging the inner diameter of  $F_1$ , and thus con-

necting  $D_1$  and E. The movement of the lever for thus operating the clutch is effected by the sliding spline V, which has keyed to it a series of cams  $U_1$ ,  $U_2$ , etc. When this spline is shifted axially on shaft E to bring cam  $U_1$  in the path of the revolving lever  $S_1$  (the direction of revolution being immaterial), the latter, as soon as it strikes  $U_1$ , is forced outward, spreading ring  $Q_1$  and engaging the clutch. Supposing, for instance, that clutch ring  $Q_1$  and lever  $S_1$  are revolving in the direction of the arrow, and that shaft E is being started from a state of rest; it is evident that the rotation of the ring and lever will cause the latter to ride up on the cam until the clutch is fully engaged, when, since E is rotating at the same rate as  $Q_1$ , the relative movement of  $S_1$  and  $U_1$  will cease so

that the clutch will not be tightened more than is necessary to carry the load. If slippage occurs at any time, this will simply cause lever  $S_1$  to ride still further over the cam, tightening the clutch still further. Any slippage thus tightens the clutch the exact amount required to carry the extra strain.

One of the interesting points in the design of this clutch relates to the matter of relieving the face of the clutch ring for the oil, where the driving surfaces come together. As is well known, clutch surfaces which run in oil must be grooved so as to allow the parts to come quickly to a bearing. In the case of this clutch, it was found necessary to groove the periphery

of rings  $Q_1$ , etc., to such an extent that the bearing area was divided into about  $\frac{1}{4}$ -inch squares, separated by oil channels. This permits the lubricant to be squeezed out almost instantly. If larger undrained areas had been permitted, the squeezing out of the oil would have taken some time, and as long as it remained, the full driving force would have come from the engagement of lever  $S_1$  and cam  $U_1$ ; as these parts, with the acute contact surface between them, could not have been made strong enough to stand the strain of the full driving power, this complete grooving is necessary for the operation of the clutch. The builders advise the use of a thin free-flowing oil for the head-stock mechanism.

It will be noted that no adjustment is required, the clutch adjusting itself, each time it is used, to the amount required by the load. It may also be seen that the amount of slippage that takes place before the clutch is engaged is predetermined by the shape of the acting surfaces of the lever and cam, as there is no possibility of the parts ever slipping for more than the merest fraction of a revolution. The wearing surfaces are far more durable than in the ordinary type of friction clutch. This durability is still further enhanced by the

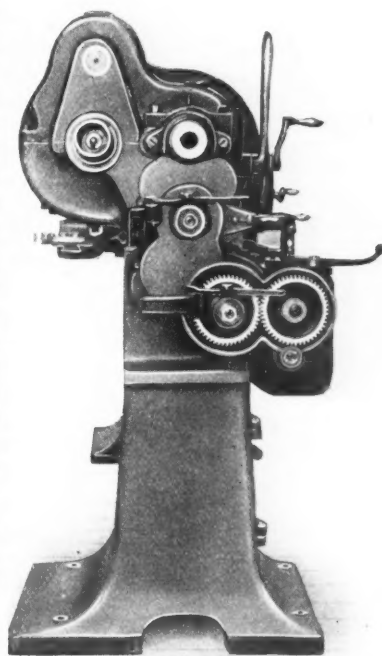


Fig. 2. End View of Lathe showing Feed Gearing Connections.

method of mounting rings  $Q_1$ , etc. These, it will be seen, are provided with circular tongues at  $a$ , entering corresponding grooves in members  $D_1$ , etc. In their open positions, these tongues closely fit the small diameter of the grooves, thus centering the rings in members  $F_1$ , etc., and holding them entirely free from these members, so that there is no rubbing

This rod has pinion teeth cut on its extreme right end, engaging a pinion on stud  $X$ , which is in turn connected by gearing with the crank shown at the front of the main bearing of the head-stock in Figs. 1 and 5. The four positions of the spline and the four corresponding speeds are indicated by the dial pointer shown.

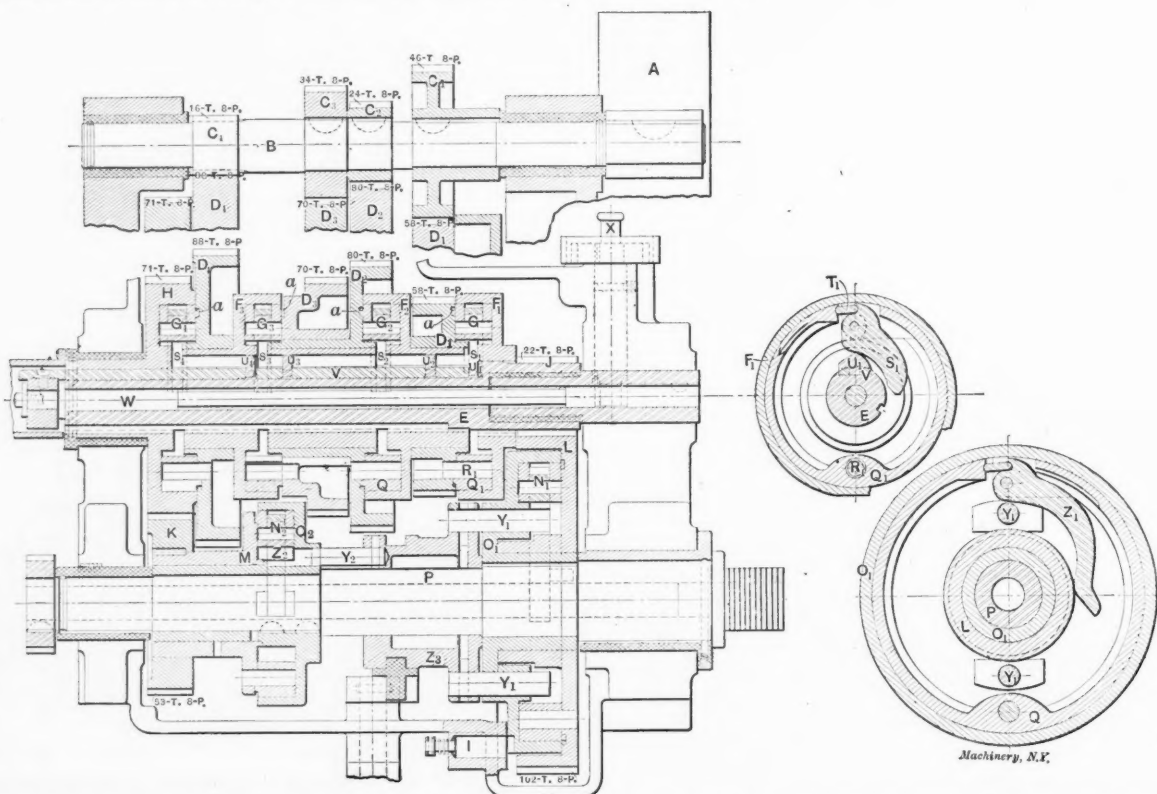


Fig. 3. Head-stock Spindle for Whitcomb-Blaisdell Lathe showing the Gearing, and the Positive-action Friction Clutches which control the Speed Changes.

of parts not in action. When the rings are spread open to engage their respective members, the free fit on the outside diameter of tongue  $a$  permits them to engage freely and without restraint.

Spline  $V$  carries four cams  $U_1$ ,  $U_2$ , etc., which engage corresponding arms  $S_1$ , etc. In the position shown, a movement of spline  $V$  to the left will bring  $U_1$  out from under lever  $S_1$ , allowing it to drop and thus releasing the clutch. Continued

Clutches  $N_1$  and  $N_2$  are identical in principle with clutches  $G_1$ ,  $G_2$ , etc., though they differ slightly in construction, as shown in the lower face view at the right of Fig. 3. In these clutches cams  $U_1$ , etc., are replaced by pins  $Y_1$  and  $Y_2$ , which engage levers  $Z_1$  and  $Z_2$ . These pins are fast in the sliding collar  $Z_3$ , which is shifted by means of the vertical lever shown at the front of the head-stock in Figs. 1 and 5. Owing to the comparatively slow motion of gear  $L$ , two pins  $Y_1$

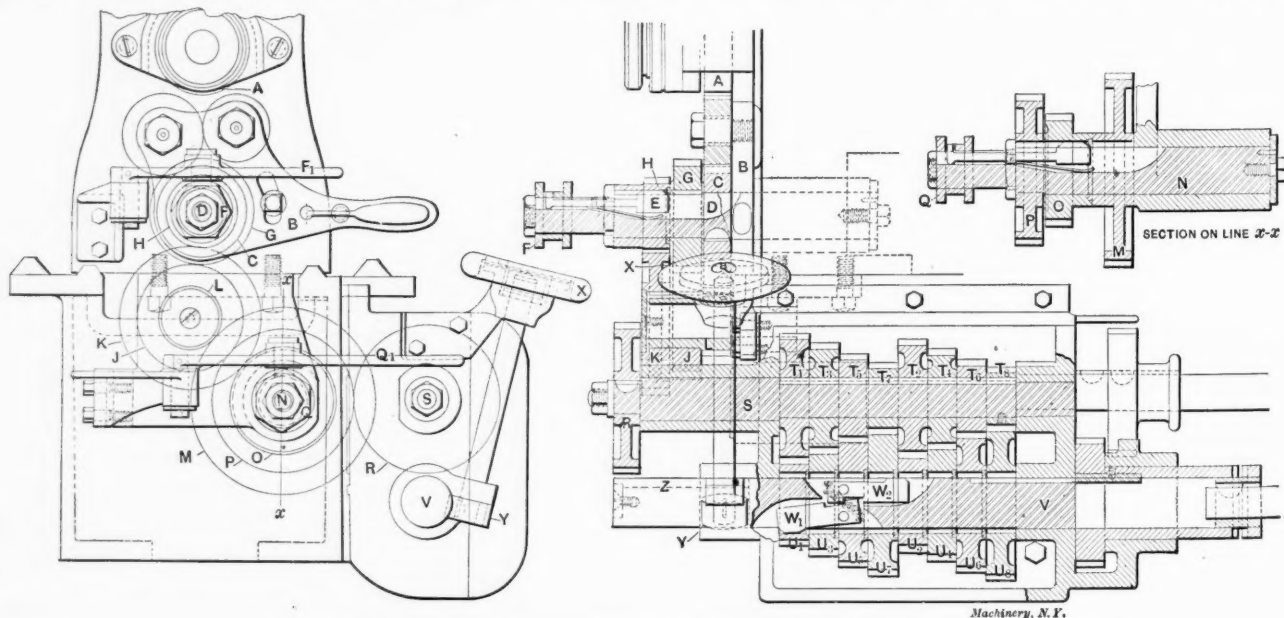


Fig. 4. The Feed Change Mechanism; note the Double Sliding Key for the Gear Box.

movement brings cam  $U_3$  under lever  $S_3$ , thus engaging this clutch. A further movement to the left carries  $U_3$  beyond  $S_3$  and engages  $U_2$  with  $S_2$ . The position farthest toward the left brings  $U_1$  and  $S_1$  in engagement. In the reversed motion, the same sequence is gone through in reverse order. This movement of spline  $V$  is effected by its connection at the left-hand end with sliding rod  $W$ , which passes through shaft  $E$ .

are provided, while but one pin  $Y_2$  is used. This insures rapid action in the clutch even at slow speeds.

The only criticism that came to the writer's mind in examining and operating these clutches related to the possibility of trouble from a faulty engagement of cams  $U_1$ , etc., with their corresponding levers. Such a faulty engagement might take place, if  $U$  were brought under  $S$  at just the time the

latter came around, so that the engagement took place on the corner. It appears that this sometimes happens, without ill effects, however. If the corners of the engaging surfaces are new and sharp, *U* may easily be pressed into complete engagement. If the corners of these surfaces should be rounded from long usage, they disengage themselves and the operator throws them in again immediately.

A detail in the construction of the head may be noticed at *I*; this is a spring plunger which may be pressed into engagement with corresponding notches in the face of member *O*, which is keyed to the spindle. It is thus possible to lock the spindle for unscrewing chucks, faceplates, etc., from the nose.

#### The Feed Changes.

Provision is made in this lathe for thirty-two changes of feed for turning or threading, without removing or changing the gearing. Figs. 2, 4 and 5 show how this is effected. The feed driving gear *A* on the spindle is connected through the usual reversing tumbler gearing on sector *B*. Gear *C* is keyed to shaft *D*; this shaft is slotted for sliding key *E*, operated through collar *F* by horizontal lever *F*. Key *E* may be set to drive either of gears *G* and *H*; these are separated by the hardened internal collar shown, which withdraws the key from one before it engages with the other. Gears *G* and *H*

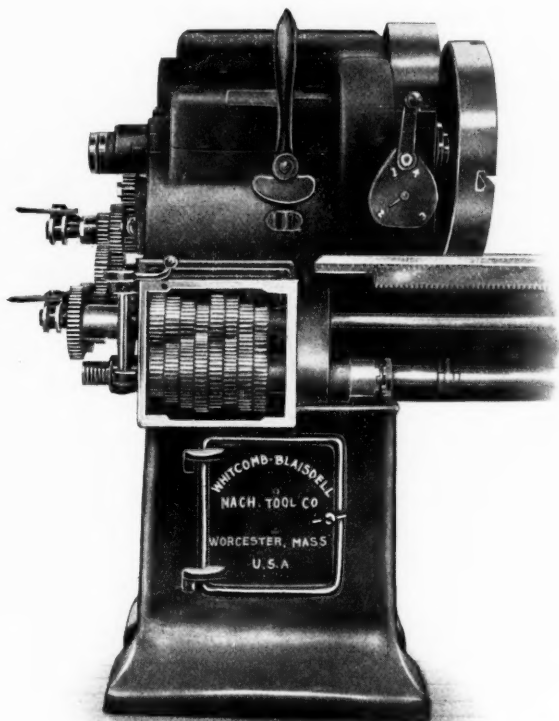


Fig. 5. View of Head-stock End of Lathe, with Gear Covering Removed.

mesh with corresponding gears *J* and *K* keyed to the hub of pinion *L*, which thus may be given either of two rates of speed. *L* and *K* engage gears *M* and *O* on shaft *N* (seen best in the detail at the upper right-hand of Fig. 4) through a sliding key arrangement exactly similar to that in the shaft *D*. Either of gears *O* and *M* may be engaged to *N* by the shifting of collar *Q*, and the horizontal handle *Q*, attached to it. Shaft *N* thus has four rates of speed, which are transmitted through gears *P* and *R* to shaft *S*, in the feed box proper.

This feed box is of the sliding key variety, but differs radically from the usual type in the details of its construction. This will be inferred from the arrangement of the gears, as shown in Fig. 5, where it will be seen that they are disposed in the form of a double cone on each axis. The reason for this will be apparent in the line drawing, Fig. 4. Gears *T*<sub>1</sub>, *T*<sub>2</sub>, *T*<sub>3</sub>, etc., are keyed to shaft *S*, which, as explained, can be connected with the spindle in four different ratios. These gears mesh with mating gears *U*<sub>1</sub>, *U*<sub>2</sub>, *U*<sub>3</sub>, etc., on sliding shaft *V*. These gears are engaged with *V*, in turn, by keys *W*<sub>1</sub> and *W*<sub>2</sub>, which are pivoted to *V*, and are connected with each other by the spring and interlocking surface shown, so that when one moves into engagement the other drops out, and vice versa.

This alternate movement in and out of engagement is effected by the hardened washers placed between each of the gears. As *V* in Fig. 4 is shifted to the right, the washer between *U*<sub>1</sub> and *U*<sub>2</sub> throws key *W*<sub>1</sub> out of engagement and puts a tension on the spring connecting *W*<sub>1</sub> and *W*<sub>2</sub>, so that the latter is thrown into engagement with the spline in gear *U*<sub>2</sub>, as soon as it comes into position to do so. A further movement of *V* disengages *W*<sub>2</sub> and throws *W*<sub>1</sub> into engagement with *U*<sub>3</sub>. The order of engagement as *V* is shifted to the right is thus, *U*<sub>1</sub>, *U*<sub>2</sub>, *U*<sub>3</sub>, *U*<sub>4</sub>, etc.

*V* is shifted by means of a sleeve *Z* attached to its outer end, which has rack teeth cut in it meshing with pinion *Y*, at the

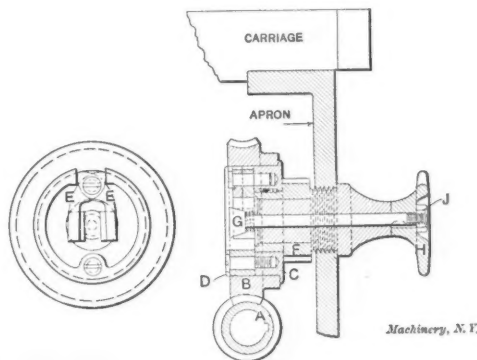


Fig. 6. Adjustable Friction Drive for Apron Feeds.

lower end of the vertical rock shaft shown in Figs. 2, 4 and 5. This shaft has a handle or knob *X*, and carries a dial with figures corresponding with the pair of gears engaged. Referring to the feed and thread plate at the front of the head-stock, the operator may find the number of threads per inch given by each of these eight positions, in combination with the four changes effected by the horizontal levers. The feeds are five times as fine as the threads.

The advantages of this form of gear box lie in the short axial movement required for the sliding keys, and the correspondingly compact arrangement of the controlling mechanism for the eight changes. It should be noted also, that, owing to the fact that when one of the keys is in engagement the other is withdrawn, there is little wear on the hardened washers separating the gears. A much better selection of threads has been provided in this box than usual, owing to the fact that the gears have not been limited to even pitches. Where it was necessary in the gear box, in obtaining a desired ratio, to employ fractional pitches, this has been done without hesitation, so that the pitches of different gears vary, though they are most of them about nine diametral. Each of gears *U*<sub>1</sub> and *U*<sub>2</sub> has six splines in its bore, so that they engage

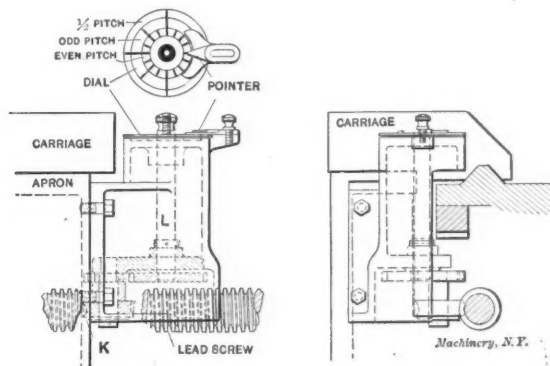


Fig. 7. Improved Screw-cutting Dial for throwing in Split Nut.

quickly. Provision is made for disconnecting either the feed rod or the lead-screw from the feeding mechanism, by means of the sliding gear and sliding clutch shown at the right of Fig. 4.

#### The Carriage and Apron.

The details of the carriage construction follow the standard practice of the builders in most particulars. There are, however, two points of improvement which are worth mentioning. One of them relates to the friction drive for the feed. This is shown in section and plan in Fig. 6. The worm *A*, keyed to the feed rod, engages a wormwheel *B* which normally revolves

loosely on clutch body *C*. Split friction ring *D*, pinned to *C*, may be spread apart by the double levers *E*, so that the worm-wheel drives *C* and the pinion *F*, to which, in turn, *C* is pinned. Levers *E* are spread apart by turning bolt *G* so that the circular portion of its head, instead of the flat portion, is brought around between the ends of the levers. Bolt *G* is turned by knob *H* on the outside of the carriage. The improvement in its construction lies particularly in the method of adjusting the clutch from the outside. This is done by nut *J*, which

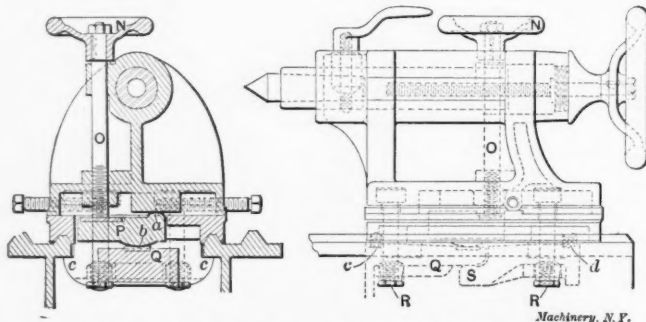


Fig. 8. Tail-stock, showing Method of Clamping at the Four Corners with Single Hand-wheel.

draws in bolt *G* against the pressure of the spring under its head. Owing to the conical shape of the round portion of the head of *G*, the axial movement operates to spread the levers further apart, and thus adjustment is made for wear.

Another improvement in the construction of the carriage relates to a threading device which has been provided. This is shown in Fig. 7. The principle of the arrangement, it will be observed, is the same as that employed on other makes of lathes for indicating the points at which to throw in the half-nut to "catch the thread" when running the carriage back by hand for a new cut in threading. Worm-wheel *K* meshes with the lead-screw and is always in engagement with it. This is connected by gearing in the ratio of 2 to 1 with the vertical shaft *L*, which carries at its upper end a revolving dial having graduations indicated by a stationary pointer. The improvement consists in providing three concentric circles for these graduations, one for even pitches, one for odd pitches, and a third for half pitches. This provision makes it possible to catch the thread much quicker on even pitches than would otherwise be the case, while the cutting of half pitches is provided for. This is not usually done. The pointer is moved toward or away from the center to agree with the circle of graduations it is desired to read. It is evident from the dial that the wormwheel *K* has a pitch circumference of 4 inches.

#### The Tail-stock, Taper Attachment, Etc.

The tail-stock clamping arrangement is original with this lathe. It is shown in Fig. 8. The tail-stock is clamped to the bed at the four corners by means of hand-wheel *N*. This is keyed to the threaded stud *O*, which may thus be screwed down against the hardened plate bearing in lever *P*. This latter is fulcrumed at *a* against the under side of the tail-stock, and has a spherical boss at *b*, which bears against a hardened plate on clamping lever *Q*. This latter is hung from spherically seated nuts on studs *R*, which form a fulcrum for it. The outside ends at *c* bear on the under side of the ways of the bed, clamping the tail-stock at the front end. Pressure is also transmitted from lever *P* through lever *Q* to the outer end of lever *S*, which in a similar way through similar bearing points *d*, clamps the rear end of the tail-stock. Springs near bearing points *c* and *d* throw the clamping surfaces out of engagement when hand-wheel *N* is screwed back to relieve the pressure.

The advantages of this arrangement lie in the very firm clamping which can be obtained, and in the handiness of the operation, it being necessary to make but one movement to clamp the tail-stock. Ordinarily there are at least two, and sometimes four nuts to be tightened. The workman is often careless about this, tightening only one. With this

arrangement, the clamping action is simultaneous at the four corners with but one movement. Of course in adjusting the tail-stock, it is necessary to so set the nuts or studs *R* that the clamping action is evenly distributed.

Among the advantages of this lathe is that common to all lathes of the single pulley constant speed type, namely, that of delivering the same horse-power through all the changes of spindle speeds. In addition, this lathe never has to be slowed down to make any change in speeds or feeds, all of which may be effected by an unskilled operator, at full speed, or under the heaviest cuts. All the gearing in the head runs in oil, and it has been found to require no attention after many months of continuous operation, and then the only requirement was that of refilling with oil. The construction will thus be seen to possess marked advantages from the standpoints of both operation and maintenance.

#### DIAMOND MACHINE CO.'S FACE GRINDER.

The accompanying engravings show the general features of a large face grinder which has been designed by the Diamond Machine Co., of Providence, R. I. While this machine was planned with reference to the particular work of grinding locomotive guide bars, its construction is such that it will be found useful for the general run of surfacing operations in the ordinary machine shop.

The machine consists, as may be seen, of a reciprocating work-table, sliding on a long bed, which carries the work back and forth before the face of a large ring emery wheel, held in a steel-bound adjustable chuck, which so supports the wheel

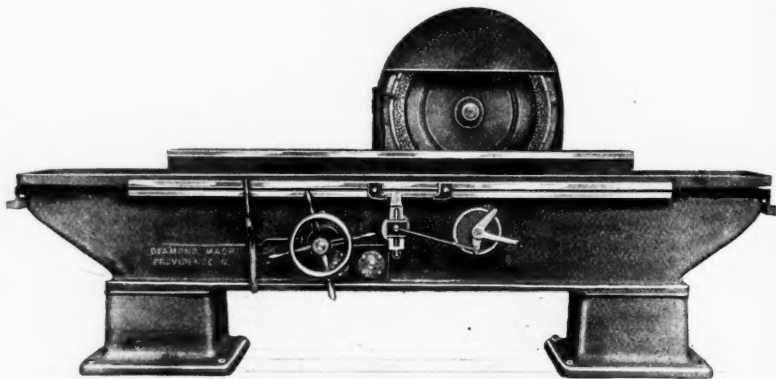


Fig. 1. Face Grinder for Finishing Guide Bars and General Work.

as to make it entirely safe at any reasonable speed. The bearings are of ample area, and are lined with a high grade of babbitt; they are ring oiled, and protected from dust. The end pressure is taken by a ball thrust bearing. The longitudinal table movement is obtained by an open and cross belt

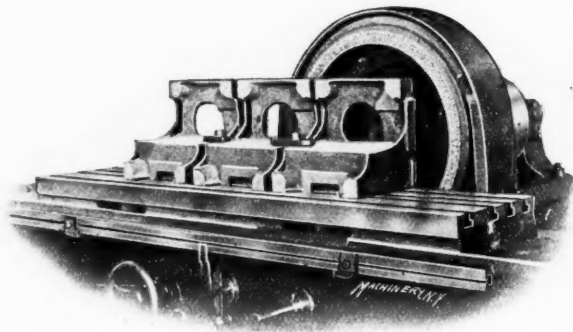


Fig. 2. Facing Machine Parts on the Grinder.

reversing mechanism, connected to the table rack by heavy gearing. The mechanism used is similar to that found on the planer. It is regulated for any desired length of stroke by the shifting of adjustable dogs. When it is desired to operate the table by hand, the clutch is thrown in to connect, with the table gearing, the hand-wheel shown at the front of the bed. The cross feed is effected by adjusting the spindle head axially along the rearward extension of the bed on which it is

mounted. This cross feed is shown connected for automatic control in Fig. 1. It is capable of very fine adjustment.

One of the advantages claimed for this machine in the work of finishing flat surfaces, is the fact that it works with equal facility on hard or soft iron, or may even be used for hardened steel. The work does not need to be so rigidly fastened as on a planer or milling machine. The movements of the mechanism are of great rapidity, as compared with those of other machines for this class of work. It has been profitably applied to such miscellaneous operations as the finishing of machine columns, water meter cases, water pipe flanges, lathe legs, floor plates, etc. It is shown in Fig. 2 grinding a casting of a form often met with in machine shop work.

This machine is built in either 7-foot or 9½-foot lengths, and for belt or motor drive. Longer machines can be made if desired. On the 7-foot machine the clamping surface of the platen is 7 feet long and 17½ inches wide. The table travel is

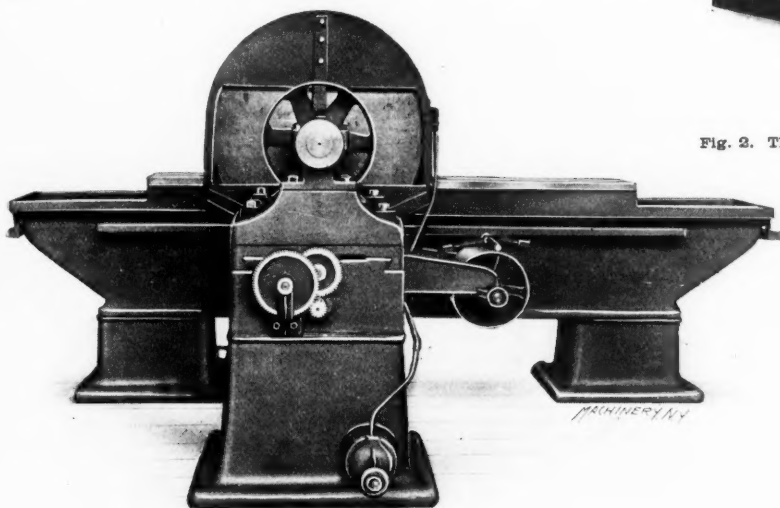


Fig. 3. Rear View of Diamond Face Grinder.

at the rate of 20 feet per minute. The wheel is 30 inches in diameter and runs from 350 to 700 revolutions per minute, depending on the nature of the work. The wheel spindle bearing is 3½ inches in diameter and 10 inches long. The floor space required for operating is 18 feet 4 inches long by 7 feet wide. The weight complete, with counter-shafts, is about 8,000 pounds; with a motor drive which is self-contained, the weight is about 10,000 pounds. An automatic pump with suitable attachments for wet grinding is furnished on all machines.

#### SCHELLENBACH-HUNT UNIVERSAL MICROMETER AND SURFACE GAGE.

The four half-tone engravings published herewith give a very good idea of the range of usefulness offered by a new micrometer measuring instrument, made by the Schellenbach-

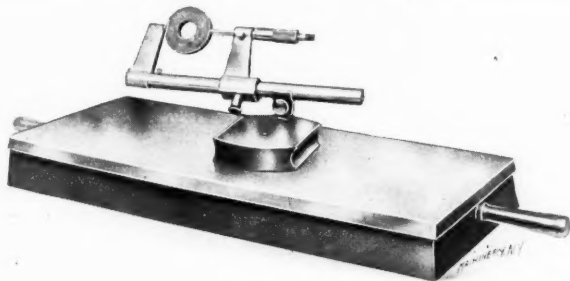


Fig. 1. Schellenbach-Hunt Measuring Instrument arranged as a Bench Micrometer.

Hunt Tool Co., Cincinnati, Ohio. It is intended to be used as a wide-range micrometer caliper in either of the two positions shown in Fig. 1 or Fig. 2, as a height gage (see Fig. 3), or as a micrometer scratch gage for laying out work as shown in Fig. 4. All these various applications are possible with very little change in the instrument itself.

As may be seen in Fig. 1, where the instrument is arranged as a bench measuring instrument, the micrometer head is carried by a sliding jaw, which is adjustable to eight different positions on the bar or beam of the caliper. The bar can be shifted endwise to any desired position in the base clamp, and

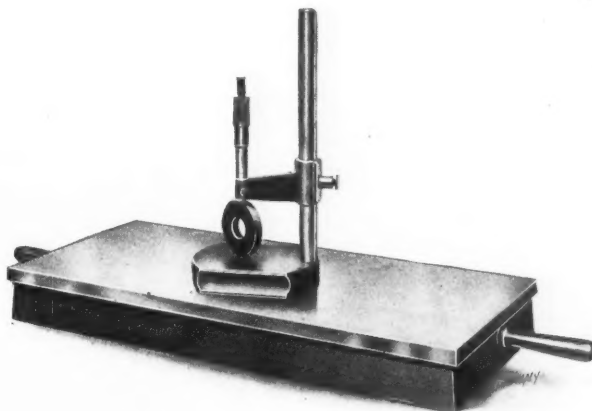


Fig. 2. The Same Instrument used as a Micrometer on an Anvil Base.

by a quarter turn backward, the instrument can be lifted out of the clamp and be placed inside or outside of the jaw, as may be necessary to permit it to be moved to the desired location as indicated by the graduation on the bar. These locations, of course, are for even inches. The length of the jaws is such that round work up to 4 inches in diameter, and flat work up to 7 inches in length, can be calipered to thousandths of an inch.

The location of the sliding jaw on the bar is determined by conical holes in the center of the flattened side of the latter. To set the jaw, it is only necessary to slide it to approximately the desired position and then screw the locating pin down until its conical end seats itself in the

bar. This both positions and clamps the jaw rigidly at the same time. The bar, as well as the locating pin and the bushing which guides it, are hardened, ground and lapped.

In Fig. 2 the instrument is seen with its fixed jaw or anvil head removed, and with the bar clamped in position on the

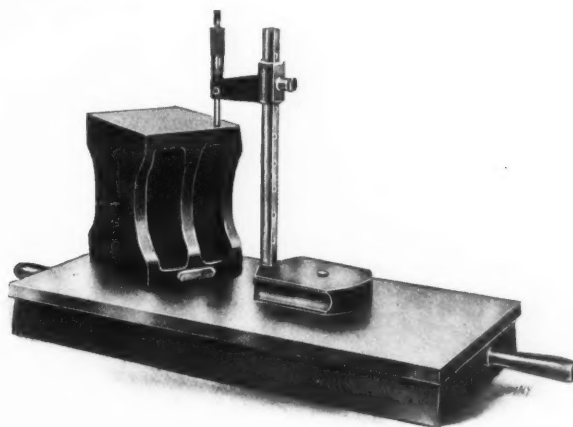


Fig. 3. Arranged as a Height Gage, whose Capacity may be Increased by Height Blocks such as shown.

base, with the point of the measuring screw over an anvil point in the latter. A 2-inch reference disk is shown held between the measuring points, as in Fig. 1. The capacity of the tool when used in this way is the same as before. The bar is drawn to its seat in the base by the same screw used in connection with the anvil head.

In Fig. 3 the instrument is arranged for use as a micrometer height or surface gage. The change from Fig. 2 is merely that of turning the bar half way around. In this position any distance from 0 to 8 inches in height can be measured. By the use of cast iron height blocks, such as shown in place under the measuring screw, the range can be extended. The makers

furnish these blocks 6 and 12 inches high; with them, the instrument has a range of from 0 to 26 inches by thousandths of an inch. They are useful in setting the tables of milling and boring machines to exact position in relation to the centers of their spindles, and in connection with measuring the

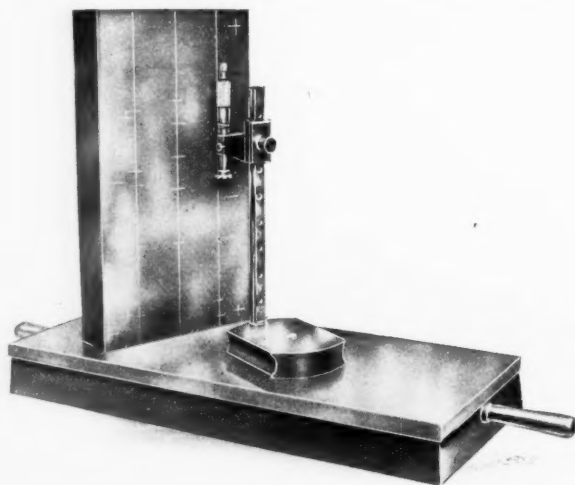


Fig. 4. The Tool arranged as a Micrometer Scratch Gage—laying out Centers for Boring.

various heights of planed and milled surfaces, the location of jig bushings, etc.

In Fig. 4 the instrument is shown with a special circular scribing tool attached to the end of the measuring spindle. When so arranged, it becomes a precision scratch gage—a tool which should be appreciated by any one having to do with the laying out of holes and machined surfaces in work requiring fine measurement. The lower face of the scribing disk is ground at right angles to its bore, while the upper side is ground at a slight angle and to a sharp edge, which is notched. The points formed by the notches are the scribing elements. The lower side of the disk is drilled and tapped for a screw, the head of which projects over the edge of the bore, and locates the scribing lines in the plane of the end of the measuring spindle. The disk is slotted, and is clamped to the spindle by means of a tightening screw. The cutting points are kept sharp by grinding, in the same way that a formed gear cutter is ground. As the face of the disk is a plane surface, grinding the notches to keep the scribing points sharp can be continued indefinitely, without destroying the accuracy of the cutter.

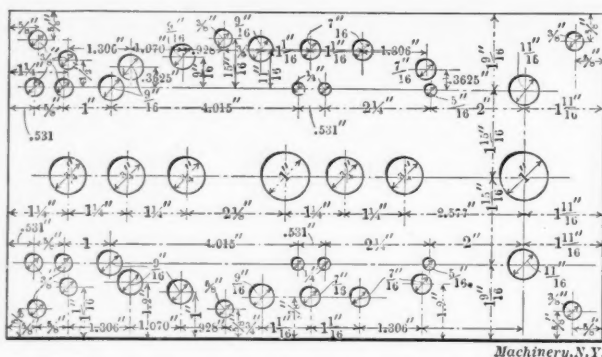


Fig. 5. Diagram of Work being Laid Out in Fig. 4.

The particular piece of work which is being laid out in Fig. 4 is shown in Fig. 5, with the measurements of the various holes which are to be drilled in it. The locating of these, it will be seen, involves the taking of a great many measurements, which are made with facility and accuracy when this

instrument is used. The measurements from one edge are first made and then the work is placed on its other face and lines scribed for measurements at right angles to the first. The intersections locate the various holes. When used in connection with the height blocks, such as the one shown in Fig. 3, lines may be drawn on work from within 1/16 inch of the base surface to the full range of the instrument, which is 26 inches, as described. It is, of course, understood that the micrometer spindle should be locked before the scribing is done. The provision of a scratch gage which can be set to thousandths of an inch should materially assist the workman in producing good work, in the many operations for which the tool is adapted.

#### SPECIAL SKINNER CHUCK FOR HOLDING GAS ENGINE CYLINDERS.

The two engravings shown herewith illustrate a special chuck made by the Skinner Chuck Co., 94 N. Stanley St., New Britain, Conn. It is designed for holding gas engine cylinders, and is especially adapted to the work of automobile factories. In the operation for which it is used, the cylinders are bored and faced, and practically finished at one chucking.

The chuck is of the two-jawed universal type. The jaws work together when operated by either screw, being connected by rack and pinion gears which are completely enclosed. Special jaws are used to fit the exterior of the casting which is to be machined. To prevent the possibility of the work's loosening and chattering in jaws at the extreme outer end of the work, they are connected at this point, as shown,

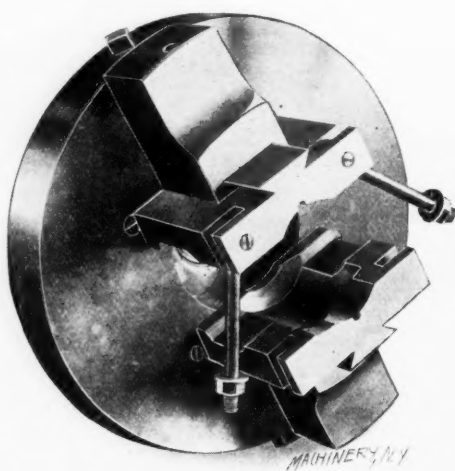


Fig. 1. Special Chuck, provided with Jaws for Holding Gas Engine Cylinders.

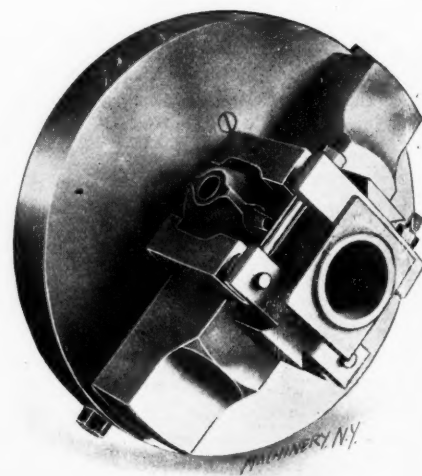


Fig. 2. Work in Place in Chuck. Note the Swing Bolts at Outer End of Jaws.

by two swing bolts, one on each side. This ties the work and the chuck together, making it practically a solid piece, and permitting heavy cuts to be taken, with the special tools usually provided for such work.

The chuck is of particular interest on account of its size. The diameter of the body is 24 inches, and the width of the adjustable jaws is 6 inches; the adjusting screw nuts are 1 1/4 inch square, and the net weight of the device is 490 pounds.

#### OSTER PIPE THREADING DIE-STOCK.

The Oster Mfg. Co., of Cleveland, O., has added a die-stock for threading pipe from 1 to 2 inches diameter, to its line of pipe-threading tools. This die-stock is so designed that the chasers automatically recede from the work while cutting, thereby forming a standard taper thread; the chasers are controlled by a cam for this purpose. On the face-plate of the die, graduations are provided by means of which special guide posts are set so as to obtain the exact size required to be cut; these guide posts, in turn, drive the cam which operates the chasers or dies. When the die has been set for cutting a certain size, the guide posts are locked by a nut at the bottom of the posts, and the setting remains unaltered as long as threads of a given size are cut. One feature of this die-stock is the universal

gripping chuck which can be adjusted to all sizes by revolving it by means of a handle. This takes the place of all bushings, and makes the die-stock entirely self-contained. The gripping jaws of the chuck are made of hardened tool steel, and consequently will not wear appreciably even after a long period of use.

#### AMERICAN 36-INCH TRIPLE-GEARED LATHE WITH TURRET ON SHEARS.

The unusually heavy turret lathe shown in Figs. 1 and 2, is built by the American Tool Works Co., Cincinnati, O. It is provided with the regular carriage, tail-stock, center and follow rests, etc., being in this respect identical with their

which is cast in the center of the lathe bed, and is used in the same manner, also, for supporting the tail-stock.

Fig. 2, taken from the rear side of the lathe, shows the supplementary feed mechanism provided for the turret slide. This is driven through reverse gearing, sprockets and chain, from the rear end of the spindle, as may be seen. By means of a sliding key arrangement, eight changes of feed are provided, operated by the knobs shown at the front of the bed, beneath the head-stock. These feeds range from 0.005 to 0.162 inch per revolution, and are entirely independent of the regular carriage and apron feeds. This feed mechanism is provided with a protecting cover which is shown removed in the engraving. The reversing of the turret feeds is a con-

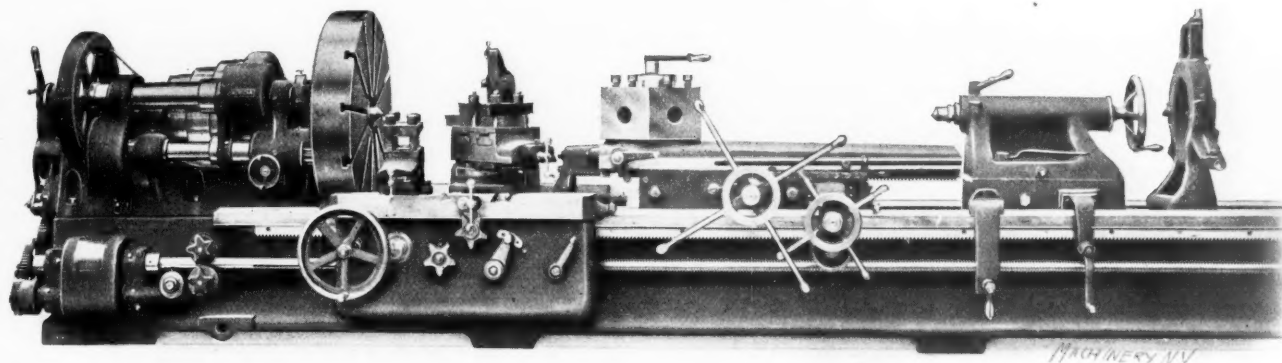


Fig. 1. Front View of Heavy "American" Lathe, with Turret mounted on Independent Slide on Shears.

36-inch heavy pattern engine lathe. The chief point of novelty lies in the turret slide itself, and in the separate feed mechanism provided for controlling it.

The hexagonal turret is indexed by a bolt located at the front of the slide, which brings the locking point very near the tool. This is superior to the usual construction, which locks it at the back, in which case slight wear of the turret locating surfaces is multiplied several times at the tool point. The turret can be indexed automatically, or by hand, or the mechanism can be set so as to be operated, if desired, to run

venient feature in such operations as back-facing and back-counterboring.

Provision is made for attaching the turret slide on the regular tool slide of the carriage, if desired, in work in which it is advantageous to employ the carriage feeds for the turret. This occurs in large tapping operations, for instance, where it is advantageous to give the taps a positive feed through the regular screw cutting mechanism. This arrangement is also of value in the ordinary work of chasing internal threads with the tool.

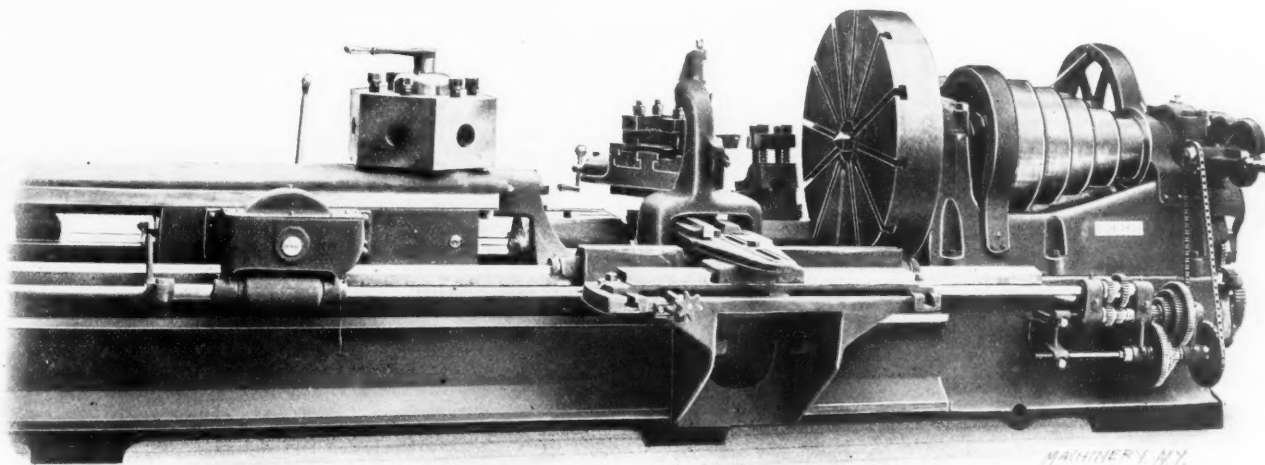


Fig. 2. Rear View of Lathe, showing Special Feed Mechanism for Turret Lathe.

the slide back to the extreme limit without withdrawing the locking pin and revolving the turret. This is done by the small lever shown near the large pilot wheel in Fig. 1.

A unique construction of the turret slide itself, gives it support at the outer end by a gibbed bracket, which travels along the ways of the lathe. This support eliminates any tendency to spring at the extreme travel of the slide. For work which requires the turret slide to pass over the carriage, this bracket can be removed. The turret slide base is moved along the bed by the small pilot wheel shown in Fig. 1. This base is clamped to the lathe bed by two eccentrics, one at each end. It is further secured from slipping under severe end thrust by a bolt which engages a ratchet toothed rack

The taper attachment, shown plainly in Fig. 2, is of heavy and substantial construction, and is designed to eliminate all cramping tendencies of the moving parts. It is supported on the bed, though the entire attachment is bolted to and travels with the carriage. It may be quickly engaged or disengaged without disturbing the taper setting. For setting the taper, a vernier arrangement is provided, with a very fine adjustment.

The general features of the lathe are well known. The head-stock is triple back-gear, the regular back-gearing being automatically disengaged when slipping the pinion into mesh with the face-plate gear, and *vice versa*. Three changes of feed or lead are provided for turning and threading, with

each setting of gears. The compound rest is provided with a tool-holder of the four stud type; a serrated base is provided for the tool. The apron is tongued and gibbed firmly to the carriage, extending its entire length. It is double, giving all the shafts a double bearing. Both the longitudinal and cross feeds are reversed from the front of the apron. All the gears and pinions are of steel of wide face and coarse pitch, cut from the solid with special cutters; they are bronze bushed where they run loose. The studs are of crucible steel, hardened and ground, and provided with convenient means for lubrication from the front. The tail-stock is strongly proportioned, with large continuous bearings on the ways; and it can be adjusted rapidly by crank and gear. It is secured against movement by a pawl engaging a rack cast in the center of the bed. The regular equipment of this lathe consists of steady, follow and full-swing rests, counter-shaft and wrenches.

#### MOTOR-DRIVEN PIPE AND TUBE CUTTER.

In the accompanying illustration is shown a No. 6 Fox pipe or tube cutter equipped with a No. 3 Westinghouse motor, the machine being manufactured by the Fox Machine Co., 815-825 N. Front St., Grand Rapids, Mich. The motor is applied to the machine in a manner permitting of a very compact arrangement, and is mounted on the machine in such a way that practically no change from the standard design is required, except that the bed is provided with two pads onto



Fox No. 6 Motor-driven Pipe and Tube Cutter.

which the motor is bolted. Instead of the regular tight and loose pulley, a large sprocket is placed on the driving shaft, power being transmitted from the motor to this shaft by a Morse silent chain. From the driving shaft power is transmitted to the cutter shaft by a train of gears. The action of the machine itself is simple. The flue to be cut off rests on two rollers shown in the foreground of the engraving, directly under the cutting disk. The position of the rollers is adjustable for different sizes of pipe, the adjustment being obtained by the hand-wheel shown. The cutting-off operation is accomplished by pressing down on the lever at the left which raises the rollers and brings the flue against the cutting disk. As an example of the capacity of the machine, it may be mentioned that a 1½-inch standard wrought iron pipe can be cut off in about three seconds, and a 4-inch boiler flue in about eight seconds. The machine is regularly equipped with an oil pump and tank for supplying lubricant to the cutting disk.

As it is often required to place machines for cutting off pipe or boiler flues in places where a line shaft is not available, a motor driven flue cutter should be of especial advantage, and will undoubtedly prove of interest to those requiring machines of this character.

#### NICHOLSON INSERTED BLADE PIPE TAP.

In Fig. 1 is shown an inserted blade gas pipe tap made by W. H. Nicholson & Co., Wilkes-Barre, Pa. These taps are made regularly in sizes from 1 inch to 12 inches in diameter—

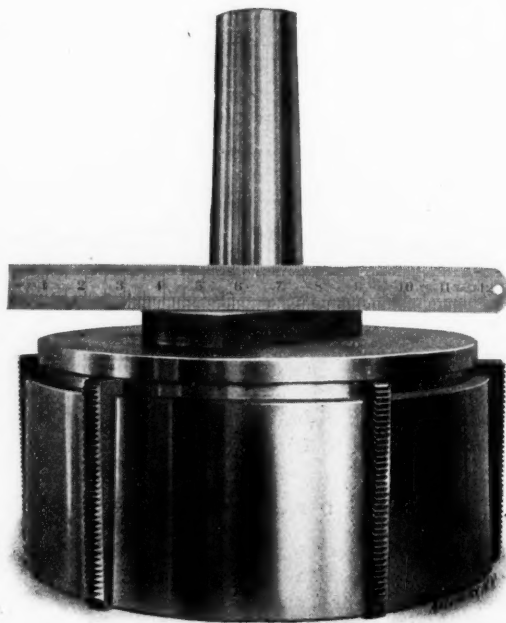


Fig. 1. A 12-inch Nicholson Inserted Blade Pipe Tap.

an example of the latter size being the one shown. The blades are made of a special grade of tool steel, which is machined with a gib on the lower edge, fitting into a corresponding groove in the body of the tap. The tap body and shank is made of steel accurately finished. After the blades have become worn, the tap can be returned to the makers, who will fit it with new blades at a small cost, making practically a new tool.

This tap is made with shanks of different forms for use in different machines. The example shown in Fig. 1 is intended

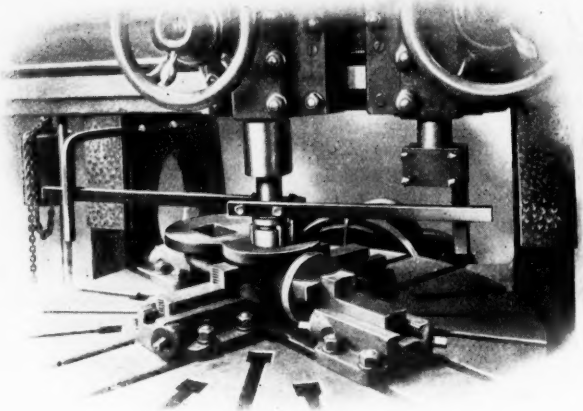


Fig. 2. Using the Tap in a Boring Mill.

to be used in a tapping machine, being provided with a taper shank and a driving tongue or tenon, to fit a corresponding slot milled in the face of the machine spindle. These tools may also be conveniently used in the lathe or turret machine. For use in the lathe, the end of the holder is enlarged and bored out to fit the outer end of the tail-stock spindle, thus giving much greater holding power than is ordinarily obtained

for tapping in the lathe. When used in the boring machine or in turret machines, the tap is provided with a cylindrical shank, as usual.

Fig. 2 shows the tap in use on the boring machine. For this work and for the lathe, a squared section is provided on the shank, to which a holding clamp or wrench is attached to prevent it from turning.

### HART'S "BUCKEYE" DIE-STOCK OF LARGE DIMENSIONS.

In the April 1908, issue of MACHINERY, an extended description of the design and operation of the Buckeye die-stock manufactured by the Hart Mfg. Co., 10 Wood St., Cleveland, Ohio, was given. The principal feature of this construction of die-stock is that the chasers which cut the tapered thread on the pipe, and which are inserted into the die body, are not as wide as the length of the thread; but by a mechanism which permits the chasers to recede from the work as they progress along the pipe, a full length thread of correct taper is cut. Another of the features of the die is that the chasers

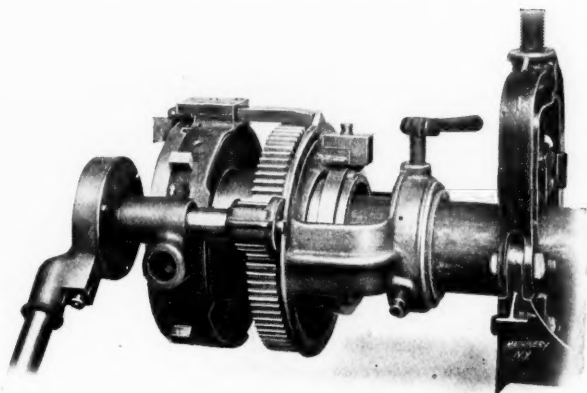


Fig. 1. Buckeye Die-stock for Cutting Taper Pipe Threads up to 4 inches in Diameter.

release automatically when the full length of tapered thread has been cut. A third feature, wherein this die differs from the ordinary die-stocks for pipe threading is in the adjustment of the dies. A wide range of sizes may be cut with the same chasers by simply loosening a screw and setting a stop to the required graduations. For a more extended description of how these features are accomplished mechanically, the description in the April, 1908, issue of MACHINERY, mentioned above, may be referred to. In adapting the Buckeye die-stock to the threading of pipe as large as 4 inches in diameter, it was found advantageous to provide the outside of the body with a large spur gear which meshes with a small pinion placed on the shaft squared on one end and which can be easily turned by a ratchet wrench of special design which is also supplied with the die-stock. The die-stock can also be operated by the ordinary die-stock handles as shown in Fig. 2. When the gear drive is used, the pinion has a planetary movement about the large gear, and its teeth are held in mesh with the gear when the body slides in and out of the frame by a member fastened to the pinion and engaging in the groove at the inside edge of the gear, this member at the same time acting as a guard for the pinion.

The ratchet wrench furnished with the die-stock can be adapted to both right-hand and left-hand threading, by remov-

ing the latch pin shown in the engraving Fig. 1 and turning it. In Fig. 2 the cutting-off attachment provided with these die-stocks is shown in operation. The cutting-off tool is fed inward by the knob on the feed screw at the outside end, while the die-stock is turned around in the same

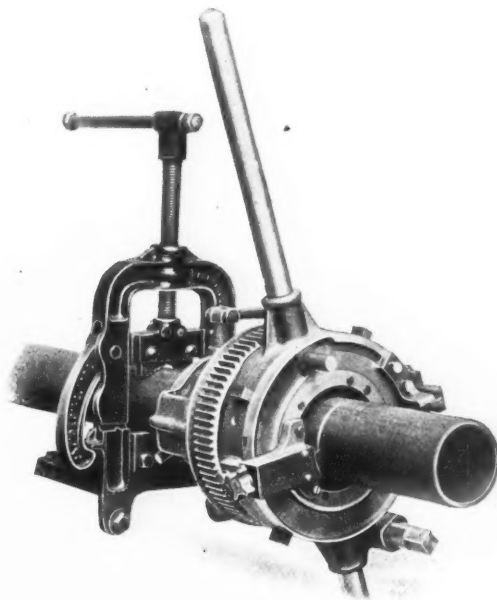
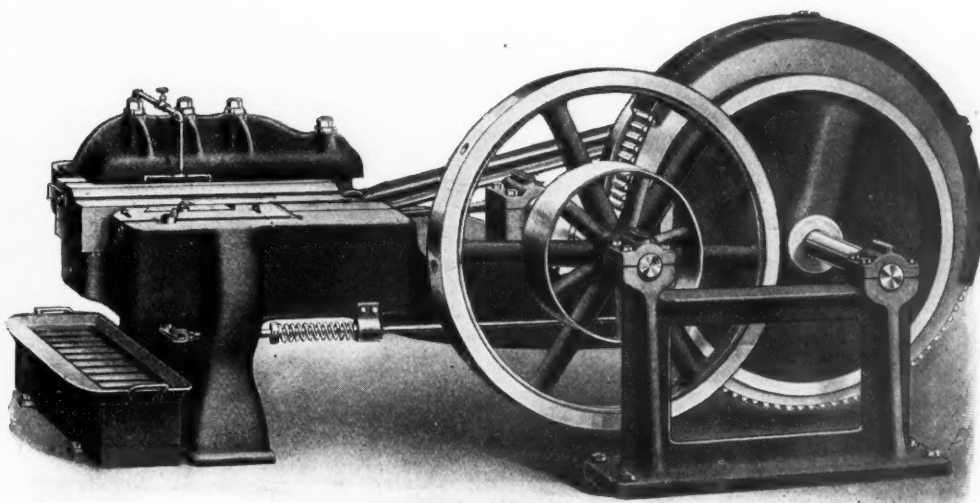


Fig. 2. Cutting-off Attachment mounted on Large Size Buckeye Die-stock.

way as when cutting threads. Back rests are provided, shaped in the same way as the chasers, but having blank end surfaces. These rests support the die on the pipe during the cutting-off operation.

### NATIONAL MACHINERY CO.'S THREAD ROLLING MACHINE.

The National Machinery Co., Tiffin, Ohio, has recently placed on the market an improved thread rolling machine, of which we show an illustration herewith. The machine is of the reciprocating type, in which the blank is started at the commencement of the stroke between flat reciprocating dies, grooved to agree with the thread it is desired to form on the



Improved Thread Rolling Machine.

bolt or screw. The movement of the die, on the forward stroke, rolls the blank through it between the grooved plates, forming the desired thread. Aside from having been redesigned throughout from the standpoints of greater power and durability, this machine has incorporated in it specific improvements in construction. One of these relates to making the slide which carries the reciprocating die, of unusual length, and backing it by a bank of hardened steel rollers, which greatly

reduce the wear and the power required to operate the machine. This slide is operated by a crank having a quick return movement, so that the machine can be operated at a high rate of speed, and still allow the operator the maximum time for feeding.

The machine has a capacity for bolt and screw threads of all sizes up to 1 inch in diameter. It operates at a speed of 35 strokes per minute, and its net weight is 18,000 pounds.

#### IMPROVED ADJUSTABLE REAMER.

An improved reamer with inserted adjustable blades has been brought out by R. M. Clough, Tolland, Conn., this reamer being known as the Style B adjustable reamer. The improvement over previous designs consists in the shortening of the reamer as compared with adjustable reamers as commonly made. On sizes over 2 inches diameter the bodies of the reamers have been made one-half, and on sizes under 2 inches, one-third the total length. The advantages gained by doing this, outside of the decreased cost, are, in the first place, that on large reamers the shortening of the body decreases the weight so that when they are used in a horizontal position the weight does not cause the reamer to run out of true; in the second place, the shorter bodies permit the bottom of the slots for the blades to be given a greater amount of taper so that practically double the amount of adjustment as compared with ordinary inserted blade reamers can be obtained. The blades are fitted in dove-tail shaped slots and adjustment for wear can be made without regrinding the blades, which is necessary when the blades are clamped by screws or nuts. These reamers are regularly made in sizes from  $\frac{3}{4}$  inch to 6 inches diameter, and provided either with a straight or taper hole for a shell reamer arbor, or with a solid, straight or tapered shank.

#### COATES POWER ERASER, DRAWING CLEANER AND PENCIL SHARPENER.

The Coates Clipper Mfg. Co., Worcester, Mass., has brought out an electrically-driven flexible shaft device for drawing-room use which can be applied for many different classes of work. As shown in the accompanying illustrations, Figs. 1

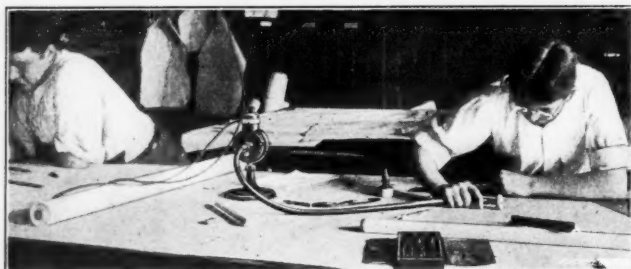


Fig. 1. Coates Electrically-driven Flexible Shaft Device for Drafting-room use, fitted with Ink or Pencil Eraser.

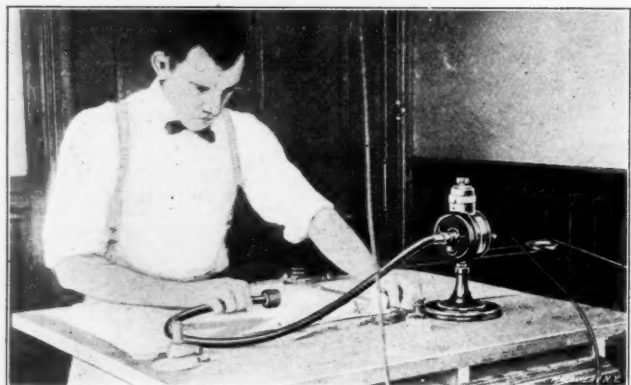


Fig. 2. Soft Rubber Roll fitted to End of Flexible Shaft for Cleaning Tracings.

to 4, a small motor, which receives its power directly from a lamp socket, is fitted on a pedestal with an independent switch. The motor is provided with a 3-foot long No. 11 Coates flexible shaft and is provided at the end with a clamp for holding circular erasers. It is a very handy instrument to use for extensive erasing on drawings or tracings, and

there is less liability of injuring the surface of the paper or cloth than is the case when erasing by hand.

The end of the flexible shaft can also be fitted with a small soft rubber roll for cleaning drawings when completed. In this way the right pressure can easily be applied to the soft rubber and the drawing is quickly cleaned without affecting

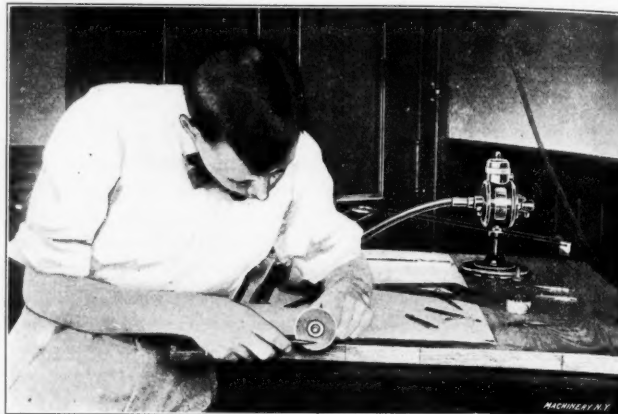


Fig. 3. Sharpening Lead Pencils on Sand Paper Disk mounted on End of Flexible Shaft.

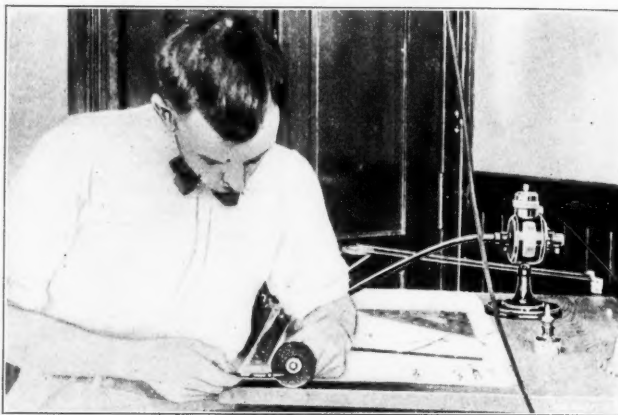


Fig. 4. Polishing Drawing Instruments on the Coates Flexible Shaft Device.

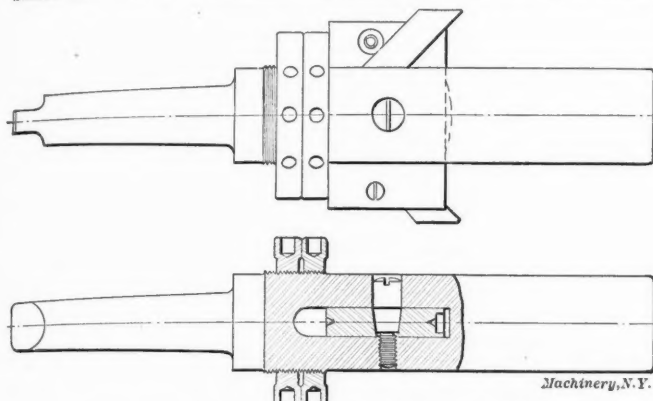
the ink lines. A sandpaper disk for sharpening pencils can also be mounted on the end of the flexible shaft. This attachment is very satisfactory for the sharpening of pencils, because as soon as the sandpaper is worn out it can easily be replaced and the pencil sharpener thus always kept in first-class condition.

If it is required to polish or burnish drawing instruments, a small crocus cloth wheel can be mounted on the end of the flexible shaft. When ink spots have been left on drawing instruments and allowed to harden, or when rust spots have commenced to form, they can be easily and quickly removed by polishing with such a wheel. The needle points can be sharpened and the tools, in general, kept in good condition. These various erasers, sandpaper disks, crocus wheels, etc., are furnished with the device.

#### KELLY CYLINDER REAMER.

In the July, 1908, issue of MACHINERY three applications of the Kelly adjustable reamer were illustrated and described. The accompanying illustration shows a new cylinder reamer brought out by the Kelly Tool Co., of Cleveland, Ohio, known as the type C reamer. Referring to the engraving, it will be seen that the reamer is mounted in a heavy boring bar, a slot being milled through this bar into which the reamer is inserted; it is held in place by a screw passing through the bar and the reamer body, the hole in the latter being tapered in order to get a proper clamping action. By tightening the screw, a solid boring tool is obtained. In finishing reamers the screw is slightly loosened, thereby allowing the reamer body to "float" sidewise in the slot provided in the boring bar, so as to compensate for any discrepancy in the alignment of the machine. A few thousandths inch, or in extreme cases  $\frac{1}{64}$  inch, is sufficient "float" to enable both blades of the reamer to locate themselves centrally with the bore, and each blade will have an equal amount of work to do, a uni-

form diameter of the hole throughout being ensured. It will be noted that the cutter or reamer body itself is made of one solid flat piece of steel and is hardened, and into this the cutters are tightly fitted, being ground to fit 10 degree dove-tailed slots in the body. Hardened gib-bushings with a 10 degree taper, supply pressure on the outer side of the blade and force it against the inner wall of the dove-tailed



Kelly Adjustable Reamer mounted in Boring-bar for Cylinder Boring.

slot. At the back of the tool is placed a hardened adjusting screw of fine pitch, which insures that the reamer will cut its exact calipered size.

For more detailed description of the reamer itself we refer to the article published in the July, 1908, issue of MACHINERY, mentioned above, the present illustration showing merely an interesting arrangement of the tool for boring cylinders and similar heavy work.

#### ALFRED BOX & CO.'S MULTIPLE DIE, BOLT AND PIPE THREADING MACHINE.

Alfred Box & Co., Philadelphia, Pa., have recently devised a bolt cutter of unusually convenient construction, being so arranged that it carries a number of dies ready in place to be used. The machine shown provides for eighteen of such dies,

which may be for pipe threads, United States standard threads, or special straight or taper threads. The machine may thus be equipped for all of the regular run of work in a shop, making it possible to do odd jobs or manufacturing operations with equal facility.

The separate dies are mounted at the front ends of short quills, carried in bearings in the large face turret. This face turret is locked by a projection on a steel spring handle, shown at the left of Fig. 1, which engages notches in its periphery. The quills are driven by clutch members at the inner end, which are

given the form of

gears, as is shown in Fig. 2. The gears form clutch teeth, which engage with similar internal projections at the front end of the hollow spindle of the machine. This spindle is driven by a large gear, meshing with a pinion on the cone pulley shaft, as shown.

In indexing to change from one die to another, the lever in back of the turret head in Fig. 2 is raised, bringing the turret

forward until the clutch driving the die is disengaged. The turret may then be rotated until the locking handle drops in the proper notch to agree with the die it is desired to use. The lowering again of the handle at the back of the turret connects that die with the driving spindle.

Provision is made for using dies of various forms. In the engravings, these dies are shown provided with guiding collars, for leading the work into the cutting edges, exactly cen-

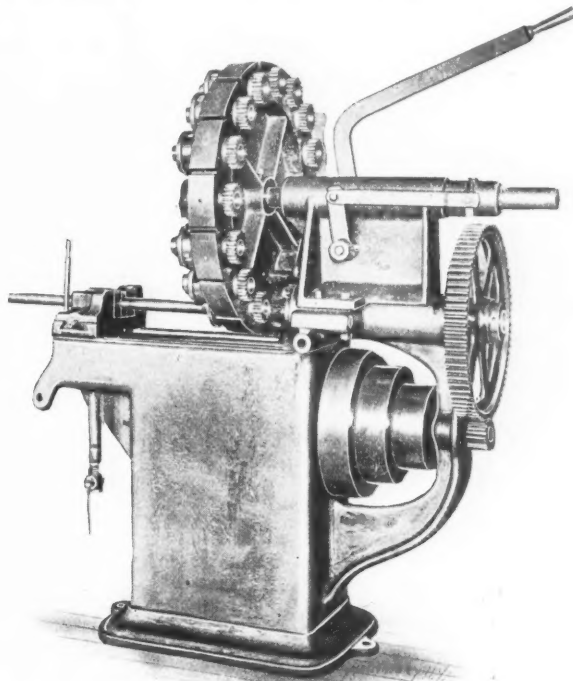


Fig. 2. Rear View of the Multiple Die, Threading Machine.

tral with the threads, thus insuring accurate results. The fact that the die quills and the driving spindle are hollow, makes it possible to work on bars of any length. The work is held from revolving by a vise, as shown.

This machine should save much time in threading bars, pipes, rods, etc., especially in shops where there is much of this work to do in small lots of varying sizes.

#### HIGH-SPEED UNIVERSAL ATTACHMENT FOR WHITNEY MILLING MACHINE.

Figs. 1 and 2 show a high-speed universal milling attachment designed for use with the well-known milling machine made by the Whitney Mfg. Co., Hartford, Conn. The purpose of this attachment is to provide for the presenting of cutters

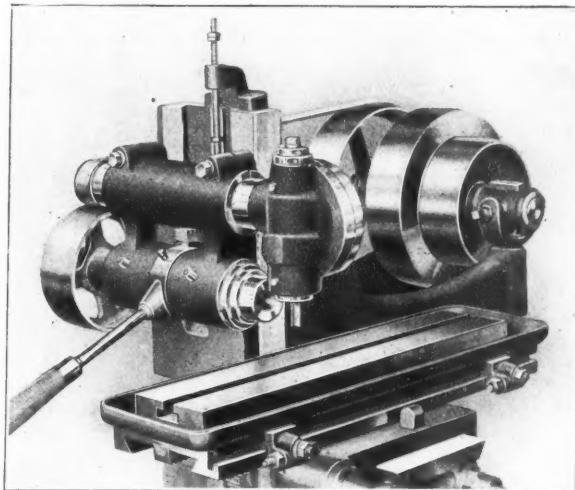


Fig. 1. Vertical Attachment for Whitney Hand Milling Machine.

to the work at any required angle in two planes; and to drive the cutter at a high speed for use with comparatively small cutters and end mills. This high-speed drive, however, is stiffly driven, and will bring out the full capacity of any tool likely to be used with it.

The attachment, it will be seen, is mounted in the seat provided for the overhanging arm in the cutter slide. It may be revolved in this seat for swiveling the cutter about a horizontal axis. It carries on its outer end a cutter spindle, mounted in a head, which is itself adjustable about a bearing on the arm, on an axis at right angles to that of the latter. This gives the universal adjustment mentioned. The drive is by belt, from the regular driving pulley, over a small pulley

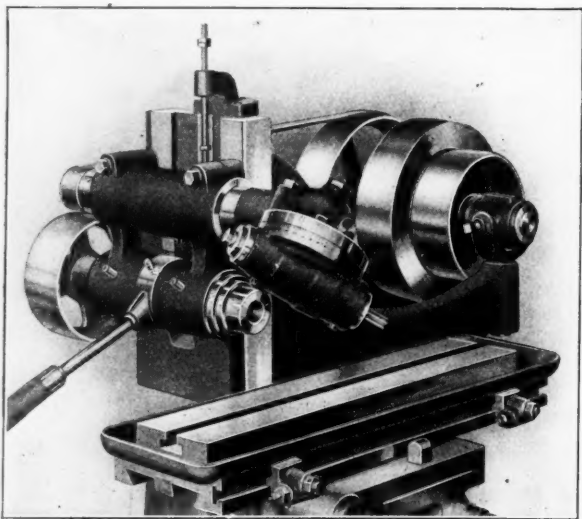


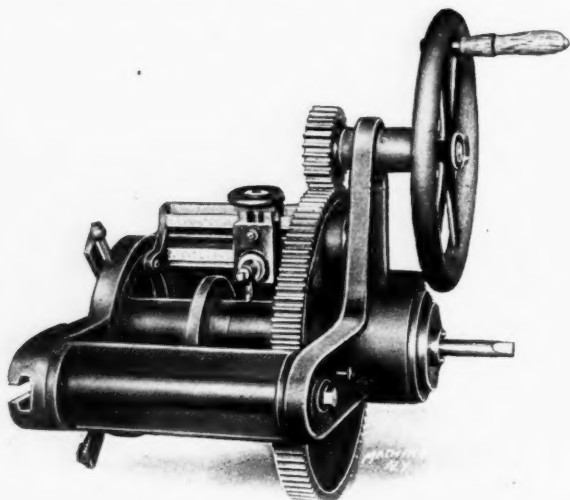
Fig. 2. Spindle of Attachment set for Angular Milling.

at the end of the shaft passing through the center of the arm. At the spindle head, the motion is transmitted from this shaft to the spindle through a train of bevel gears, which permits the universal adjustment. Fig. 1 shows the cutter spindle vertical, while Fig. 2 shows it set at an angle with the horizontal.

This tool was originally designed by a customer of the builders of this machine, the Porter-Cable Machine Co., of Syracuse, N. Y. The Whitney Mfg. Co. was so pleased with its usefulness in adding to the wide range of work to which the machine is adapted, that they have made arrangements to place it on the market.

#### STOW CRANK-PIN TURNING TOOL.

We show herewith an improved design of the crank-pin turner made by the Stow Flexible Shaft Co., Philadelphia, Pa. This device is of the type which permits the re-turning of a crank-pin while it is in place on the engine. It is supported



Portable Crank-pin Turning Machine, with rigidly supported Tool Slide.

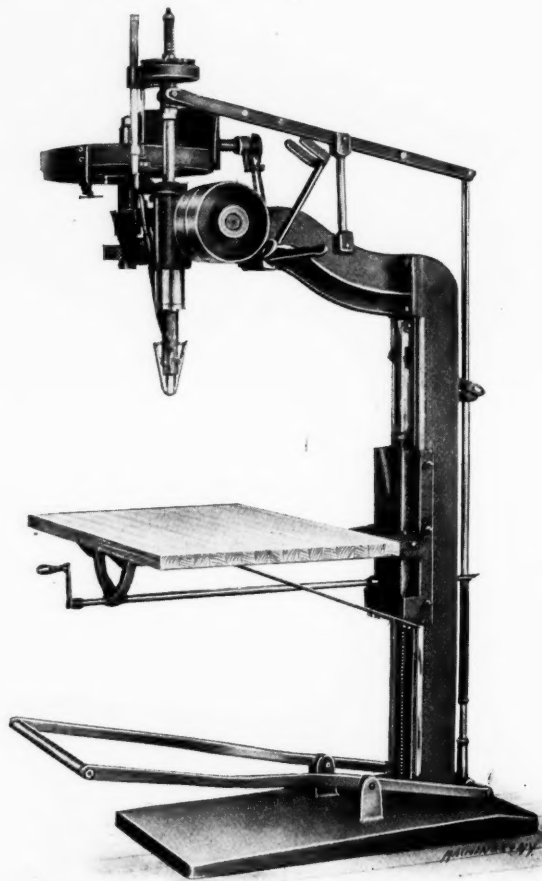
at the back end by four jaws which center the tool against the flange of the pin. At the front end, a center is provided, which is screwed into the center hole of the crank pin, thus locating the device by the axis of the pin. When located in this way it is held firmly in place by any suitable clamping device.

A particular feature of this tool consists in an improved method of supporting the outer, or free end of the tool slide.

This tool slide, it will be seen, is carried by a large gear, driven by the small pinion and hand-wheel shown. The free end of this slide is clamped to a ring, which is a running fit in a seat at the inner end of the frame. The tool slide bracket is thus supported at both ends, and is capable of doing much more rapid work than is possible with the usual unsupported construction. The various adjustments and movements of the tool can be readily understood from the engraving.

#### REYNOLDS AUTOMATIC SCREW DRIVING MACHINE.

A new design of power driven automatic screw driver has been added to the line built by the Reynolds Machine Co., Rock Island, Ill. In this line of machines the screws to be driven are dumped into a hopper or magazine, from which they are taken by a feeding mechanism which brings them into position for driving, at the end of the vertical spindle. There they are held by a pair of jaws, until the driver descends and engages the slot in the head of the screw, and forces it down into the work. The spindle, which is friction driven, runs as high as 1,000 or 1,500 revolutions per



An Automatic Screw Driving Machine for Large Work.

minute on the smallest sizes, so that the screws are driven in a fraction of a second. The capacity of these machines is limited only by the ability of the operator to get the work under the spindle, and he has both hands free to do this. Owing to the fact that the spindle is friction driven, the tightness of the drive may be limited to any desired amount.

The particular form of the machine here shown is of larger capacity than anything previously made by the builders. It will set screws to the center of a 48-inch circle, and the table has sufficient vertical adjustment to take in work 30 inches high. The table is automatically raised, just as the screw is started, by means of a cam connection with the foot treadle and spindle operating lever at the top of the machine. The treadle is so arranged that the operator can reach it from any position about the table.

In addition to the usual features of magazine feed, adjustable friction drive for the spindle, etc., the machine has a positive stop which allows screws to be merely started, or set so that the head projects any uniform height desired.

This is effected by providing a braking device for the spindle and a release for the friction drive, which become operative at any desired point in the travel. The first machine of this type was built for the U. S. Arsenal at Rock Island.

### NEWTON HEAVY FOUR-SPINDLE MILLING MACHINE.

A four-spindle milling machine of unusually massive construction is shown in the accompanying engravings. It was built by the Newton Machine Tool Works, Inc., Philadelphia,

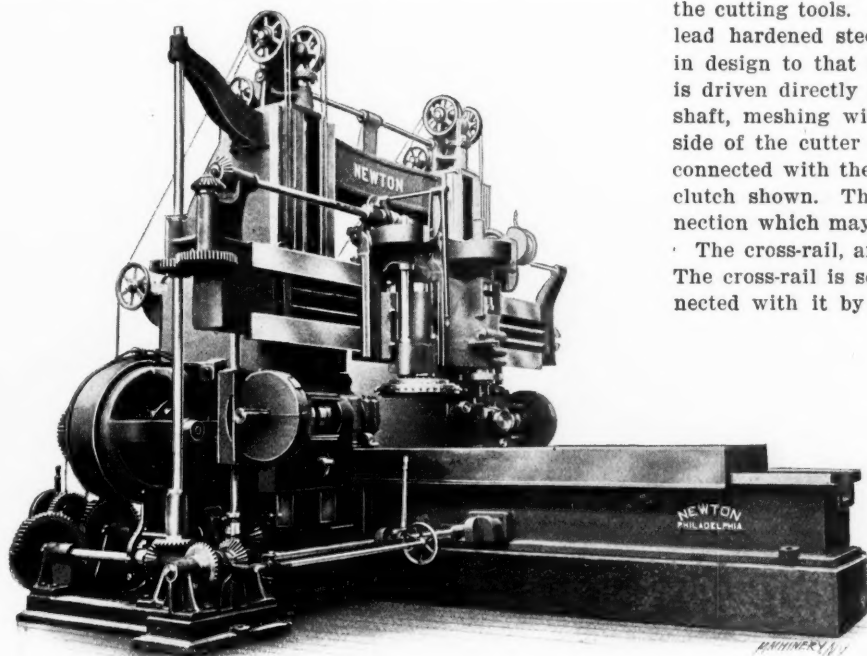


Fig. 1. Heavy Four-spindle Milling Machine, built for the Altoona Shops of the Pennsylvania Railroad.

Pa., for the Altoona Shops of the Pennsylvania R. R. The machine is of the planer type, with two side horizontal spindle heads on the face of the housings, and two vertical spindles on the cross-rail.

The machine is driven by a 50-horse-power General Electric motor, having a variable speed range from 560 to 1,120 revolutions per minute. As may be seen best in Fig. 2, this is connected through a rawhide idler pinion and idler gear to a cross shaft, from which is taken the motion for the feed and fast traverse of the two vertical heads. As is better seen in Fig. 1, from a smaller pinion on the hub of the second idler, motion is taken through a back gear drive for the vertical shafts driving the two side heads. Motion for the fast traverse and feeds is transmitted through to the working side of the machine, where it is connected with a feed box of the builders' standard design, giving nine changes. The arrangement of feeds and speeds provided makes available individual drive or simultaneous drive for the heads and feed; and fast traverse for the table, for raising and lowering of the cross rail, and for the cross adjustment of the heads on the rail.

The construction of the two side heads and of the right-hand cross rail head is similar. The spindles are 5 $\frac{3}{4}$  inches in diameter and have a bronze bushed bearing 17 inches in length, with a double taper bearing 8 $\frac{3}{4}$  inches long at the end of the adjusting sleeve. The ends of the spindle have an external thread, on which face cutters can be fitted; they are provided, as well, with a No. 5 taper for holding end mills. The spindles are provided with through holes for retaining bolts. In addition there is a broad slot milled across the end of the spindle to fit the tenoned drive of large mills and arbors. All the spindle worm-wheels are approximately 26 $\frac{1}{2}$  inches in diameter, and

are provided with hardened steel worms having roller thrust bearings. These parts are all encased and run continuously in oil. The rack sleeves in which the spindles are mounted have sufficient length to permit an independent adjustment of 12 inches for the spindle on the saddle, by means of the rack and pinion and worm gear mechanism shown.

The left-hand cross-rail head is of somewhat different construction. The spindle is mounted in a slide which has an independent vertical adjustment. The spindle carries a solid cast steel rotary planing head 26 inches in diameter over the cutting tools. This cutter head is driven through a steep lead hardened steel worm and a bronze worm-wheel similar in design to that used on the other heads. The cutter head is driven directly by a pinion on the end of the worm-wheel shaft, meshing with an internal gear fastened to the upper side of the cutter disk. This head may be connected or disconnected with the driving mechanism by the hand lever and clutch shown. The right-hand head has a back geared connection which may be thrown in or out, as required.

The cross-rail, and side heads as well, are counterweighted. The cross-rail is so arranged that the side heads may be connected with it by swing bolts, and thus elevated or lowered by power when so attached. The elevating screws have roller thrust bearings both at top and bottom, to permit pulling the cutters into the work when sinking in to depth, without putting the screws in compression. The table feed is by a spiral gear and rack, similar in design to the well-known Sellers drive for planers.

The table of this machine is 42 inches wide and 18 feet long, and the feed movement permits the taking of cuts 16 feet in length. The maximum distance between the ends of the horizontal spindles is 60 inches and the minimum distance is 36 inches. The maximum distance between the end of the horizontal spindle and the top of the work table is 66 inches. The mini-

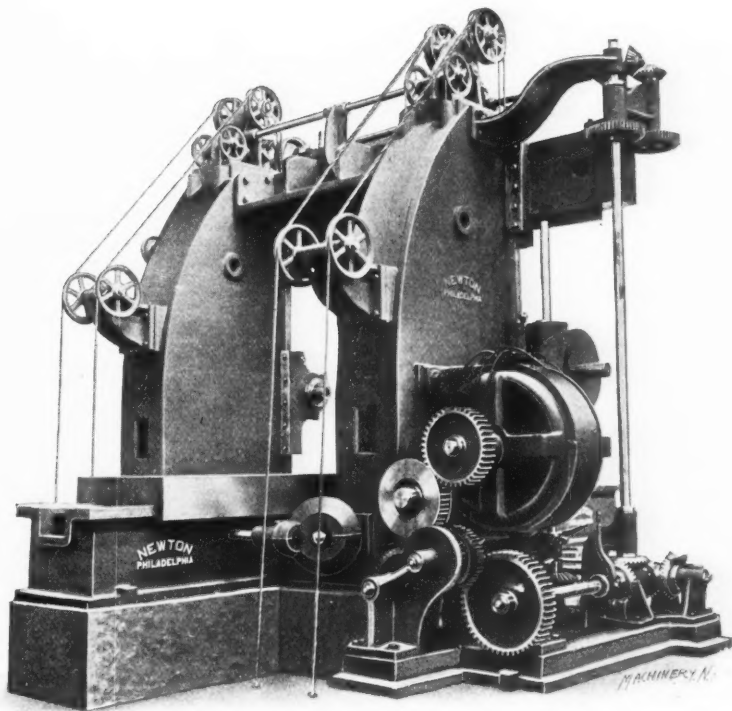


Fig. 2. Rear View of Four-spindle Milling Machine, showing Driving Gearing.

mum distance between the centers of the vertical spindles is 32 inches. The table feeds available at the high speed of the motor range from 0.789 to 8.150 inches per minute. At the slow speed of the motor, these feeds are cut in half. A quick return of about 22 feet per minute is available

in both directions. The maximum feed of the rail vertically and the saddles on the rail is  $4\frac{1}{2}$  inches per minute, with the motor on the high speed.

### "STAYIN" POSITIVE DRILL SOCKET.

The G. R. Lang Co., of Meadville, Pa., is placing on the market a drill socket which is intended to obviate the difficulties arising in high-speed drilling from the insufficient driving power of the ordinary taper shank drill with a tang. Under modern conditions this tang is much given to twist-

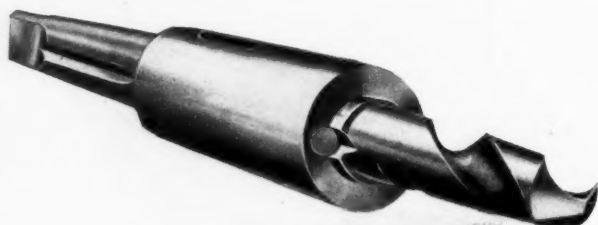


Fig. 1. A Drill Socket which relieves the Tang of all Stress.

ing off, rendering an otherwise good drill practically useless. Various appliances have been devised for using such broken drills effectively. The device here shown is intended not only for using such broken drills, but for preventing them from breaking in the first place.



Fig. 2. An Old Drill Ground for use in the "Stayin" Socket.

Fig. 1 shows a socket of this design which has, as may be seen, a round driving key set in the taper hole. This driving key engages a V-groove milled in the taper shank of the drill. The driving is done by the frictional contact of the taper surfaces, and by the positive action of the round key mentioned. The tang is thus relieved of all strain, and is



Fig. 3. The Socket and the Drills.

of use only in driving the drill from the socket. To provide, however, for drills that have had their tangs twisted off, the key slot is made unusually deep. In fixing up old drills to be used in this socket, the shank is ground flat, as is shown in Fig. 2, to give a driving surface for the key. A new and an old drill are shown separately in Fig. 3.

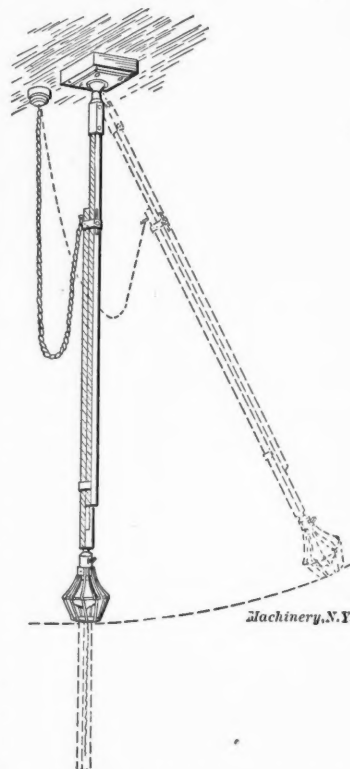
An advantage of this socket as compared with others for the same purpose lies in the fact that it not only holds the drill in the socket but holds the socket in the drill press, as well. The makers will furnish the jig for drilling a keyway

in the drill press spindle for inserting the hardened steel rods which are furnished for the purpose. The sockets are made slightly heavier than the standard type, and the key is pressed in. They are all drilled by special jigs, which bring the keys parallel with the axis and central with the drift pin hole. Being accurately finished in the lathe, the taper fit is of the highest order. The makers keep all sizes in stock at practically the same price as the old style sockets.

### ADJUSTABLE ELECTRIC LIGHT HOLDER.

The Harley Machine Co., 92 Hayden Ave., Springfield, Mass., has brought out an adjustable electric light holder suspended from the ceiling and intended particularly for shop use. As shown in the accompanying line engraving, the holder consists of a ball and socket joint, the socket being fastened in the ceiling, and two wooden bars having a sliding adjustment. The lamp is fixed to the lower end of one of the bars.

The socket consists of a steel plate pressed out in the center to fit the ball and fastened at the extreme corners so as to obtain a spring action. The upper end of the ball works in a wooden block fastened to the ceiling, and ample friction is thus provided so that the holder with the light at the lower end will stay in any position radially in which it may be placed, even though there be considerable vibration. The two sliding rods, being made of wood, provide sufficient friction so that the light can be pushed up or pulled down and still remain stationary in any position desired longitudinally. It will be seen that by this combination of movements it is possible to bring the holder to any position in a large circle about its socket and also to raise or lower the light according to the requirements. The difficulties of obtaining light in various positions, as required in machine work, recommend the use of an adjustable holder for the light, and any device providing adjustment will undoubtedly be of interest to mechanics in general.



Adjustable Electric Light Holder made by the Harley Machine Co.

### TWO WILLEY ELECTRICALLY-DRIVEN GRINDERS.

Figs. 1 and 2 show two new designs of the Willey grinder as made by James Clark, Jr., & Co., Louisville, Ky. These machines are of the regular construction of this well-known line of tools, in having the motor built into the machine itself, making an unusually neat and satisfactory arrangement.

Fig. 1 is a floor grinder for general purpose work. The motor frame and pedestal are one casting, and the starter is contained in the frame, where it is out of the way and well protected. This starter is made for this particular machine, and is not a commercial product. The armature shaft, which is also the wheel spindle, is very stiff. The motor is especially designed for grinder service, being completely enclosed from emery dust. The tool rests are so supported that they can be adjusted to any desired position. The surface grinding attachment shown over the left-hand wheel is furnished when desired at extra cost.

The addition of a self-contained wet grinding attachment makes of the machine shown in Fig. 1, the combined wet and

dry grinder shown in Fig. 2. With this arrangement, the left-hand wheel is used for dry grinding, and the right-hand for either wet or dry. The attachment consists of a hood, splashing plate for the wheel, a water reservoir, and a settling chamber fitted with a centrifugal pump. The whole is bolted to the bottom of the pedestal, and is steadied at the



Fig. 1. Willey Electrically-driven Dry Grinder.

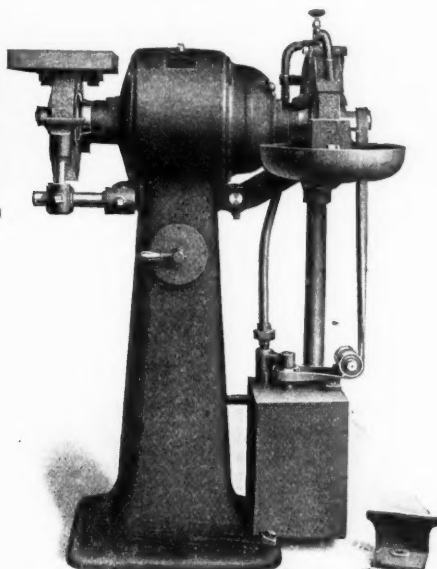


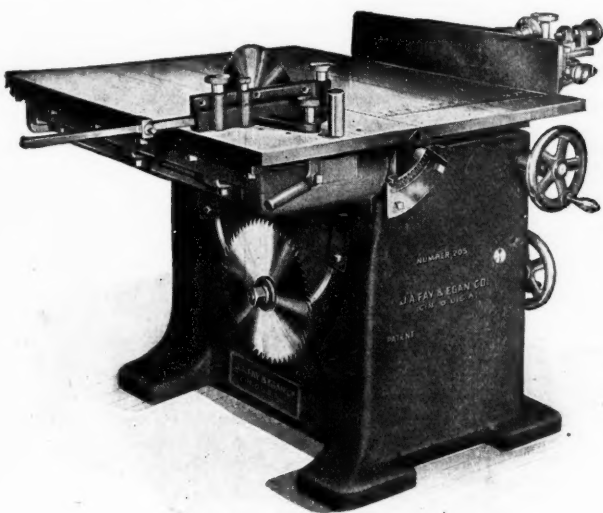
Fig. 2. The Grinder in Fig. 1, with Pump and Reservoir Attachment.

top by a second bolted connection with the frame. The pump is so made that the bearings are above water, and it has no stuffing box. It is driven from a pulley on the end of the wheel spindle, as shown.

The height of this machine over all is 48 inches. The wheels used are 12 inches in diameter by 2 inches face, and they usually run at about 1,600 revolutions per minute. The net weight of the machine in Fig. 1 is 475 pounds. With the water attachment, as in Fig. 2, it is 670 pounds.

#### FAY & EGAN DOUBLE CIRCULAR PATTERN-SHOP SAW.

The J. A. Fay & Egan Co., West Front St., Cincinnati, Ohio, is building the improved saw table shown herewith. It is of the type in which cross cut and rip saws are both permanently mounted in the machine, and either may be brought into use as required. In addition to this, the ma-



A Combination Cross-cut and Rip Sawing Machine, especially adapted to Pattern Work.

chine is provided with such a variety of adjustments, attachments, gages, etc., as to make it specially adapted to the work of the pattern-shop.

The mechanism for changing the saws and adjusting them for height is distinctly different from other machines of the kind. Both saw arbors are carried in a revolving frame.

This overhangs at the front of the machine so that it is a simple matter to take off or put on the saw without disarranging the table. Two saws up to 16 inches in diameter can be used at the same time; if only one saw is used, it may be as large as 20 inches in diameter.

The table is made in two sections; a moving section 44 x 16 inches mounted on anti-friction rollers, and a stationary section 44 x 20 1/2 inches, provided with an extension so that material up to 20 inches in width can be rip-sawed. The moving section of the table has sufficient travel to edge or cut off stock up to 35 inches in length, and it will open to permit the use of a 2-inch grooving head. The whole table can be tilted by a hand-wheel to an angle of 45 degrees with the saw face. This angle is indicated by graduations.

The ripping fence may be set to take stock up to 20 inches wide and be used on either the right or left section of the table. Micrometer adjustment is provided for setting it. The miter cutting-off fence is used on the sliding table, and covers a range from 45 degrees up to 60 degrees. On the front, as shown in the illustration, it is provided with a stop rod to be used for beveling stock to accurate lengths.

The builders will send full illustrations and descriptions of this machine and its mechanism on request.

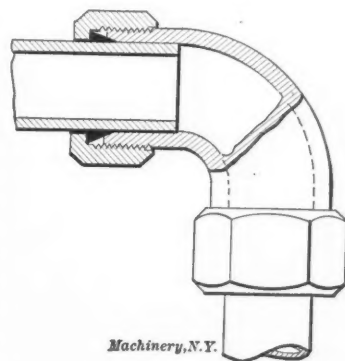
#### UNION-CINCH PIPE FITTINGS.

The line engraving shown herewith illustrates the construction of a very ingenious line of fittings, made by the Sight Feed Oil Pump Co., Milwaukee, Wis. The particular feature of this line of fittings is the fact that by their use it is possible to do a complicated job of piping, with nothing more in the way of tools than a hack-saw, a file and a pair of monkey wrenches. The simplicity of this outfit is made possible by the fact that no threading has to be done, the joints being made tight against high pressure on the smooth ends of the pipes.

In the engraving it will be seen that first a gland nut is put on over the end of the pipe. This is followed by a tapered bushing of soft metal. The pipe is then inserted in the fitting, and the nut is screwed down tightly on it, thus compressing the bushing in the tapered space between the outside of the pipe and the flared opening of the fitting. This may be tightened down so firmly as to resist leakage of pressures up to 1,000 pounds per square inch.

The advantages of this method of piping are obvious. The connections are made without soldering, flaring, hacking, or using cement of any kind. The usual pipe vise and bench, with a full set of taps and dies and an assortment of pipe wrenches, is dispensed with. Every joint is a union, so that the pipe system may be taken apart at any point and re-assembled. A neat looking job at a small expense may be made of steel or brass tubing conforming to the outside diameter of standard pipe sizes. This tubing, which will be furnished by the makers of the fittings, is inexpensive and is carefully annealed, so that it can be readily bent to any desired form.

Fittings are furnished for all required purposes. They are furnished in the form of L's, adaptors for changing from threaded to Union-Cinch pipe systems, T's, couplings, relief valves, etc. They are recommended by the makers for such work as piping up oil pumps, gravity oiling devices, gages,



An Example from the "Union Cinch" Line of Pipe Fittings, which require no Threading

and drop pipes, especially on work of this character around ammonia handling machinery, where the steel tubing and steel fittings are well adapted to keeping the system perfectly free from leakage of the ammonia gas.

### IMPROVED SPINDLE ADJUSTING DEVICE FOR MULTIPLE SPINDLE DRILLS.

The accompanying line engravings illustrate an improvement for the adjustment of the tools in metal working machines, recently patented by Mr. F. E. Bocorselski, superintendent of the Baush Machine Tool Co., Springfield, Mass. The illustrations show the device as specifically provided for a multiple spindle drill, and intended for rapid and independent adjustment of the various drill spindles both as regards their location relatively to one another in the horizontal plane as in the vertical direction.

In order to illustrate more plainly the application of the device, the head of a multiple spindle drill press is shown in Fig. 1 and the adjusting device itself is shown in detail in Fig. 2. In Figs. 1 and 2, *A* is the frame of the head of the drill press, *D* is a block attached to the frame by means of the projecting stud *B*, and *E* is a bracket containing a bushing *C* which guides the drill spindle. The object of the design is to provide a simple means by which the spindle guiding bracket *E* may be moved for considerable distance in

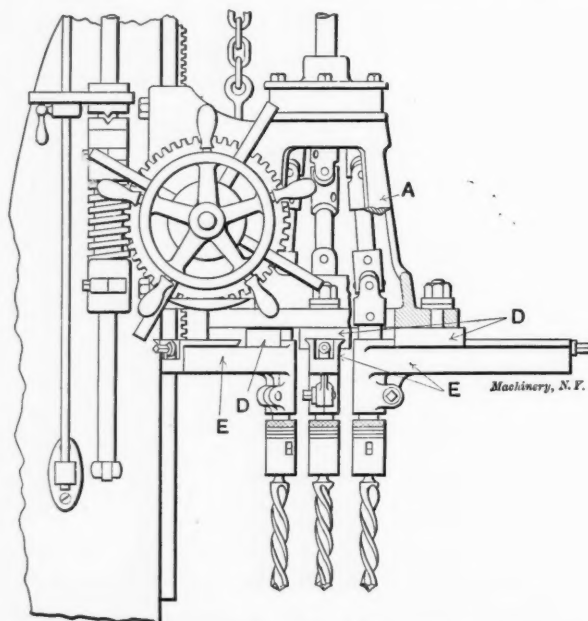


Fig. 1. Multiple-spindle Drill provided with Improved Facilities for Adjusting the Drill Spindles.

relation to the head *A* without resorting to a slow screw adjustment. When the head has been placed approximately in the correct position, the minute adjustment may be accomplished by a screw engaging with a half-nut. The device also provides for independent adjustment of the various spindles in a vertical direction, so that any one of a number of drill spindles can be so adjusted that the working end of its drill will be in a horizontal plane with the working ends of the drills in the other spindles, irrespective of the length of the drills. The object desired is accomplished in the following manner.

The block *D* having a swivel action in relation to the frame *A* permits the spindle *F* to be located in any position radially about the stud *B*. In the lower face of the block *D* a dove-tail slide is cut, into which a slide of the bracket *E* fits. The bracket is provided with a feed-screw *G* which is capable of a swiveling motion downward about the ball point at its further end, and which can by this means be thrown out of engagement with the half nut *H* attached to the block *D*. It is evident that when the feed-screw is out of engagement with the half-nut, bracket *E* can be pushed along by hand until the spindle *F* is approximately in the desired position. The feed screw is then again brought into engagement with the half-nut, and the final adjustment made by the screw. The arrangement of the screw and the half-nut is shown

more clearly in the enlarged sectional view in Fig. 3. It will be seen here that the half-nut *H* is connected by studs to a block *K* which is cut out at its upper side to fit the outside of the screw, but which is not threaded. On the lower side

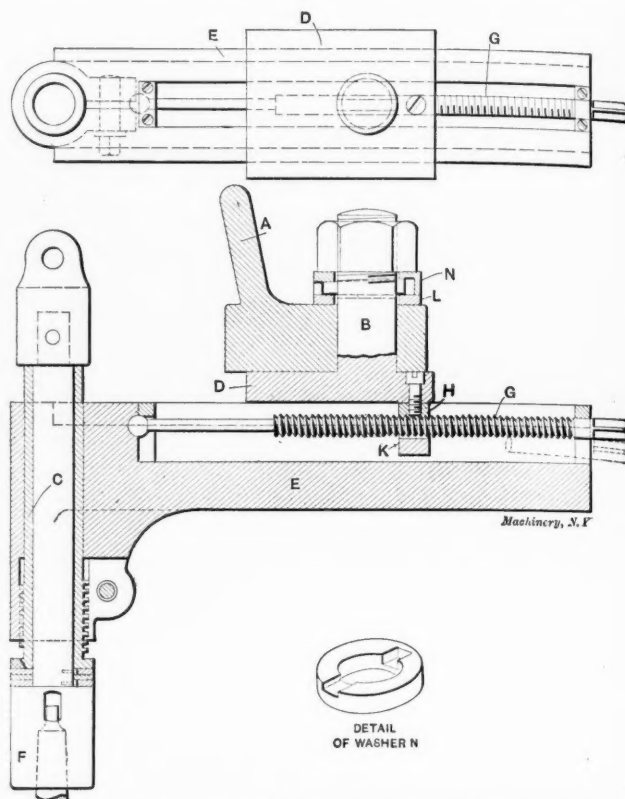


Fig. 2. Details of Bocorselski's Device for Rapid Adjustment of Multiple Drill Spindles.

of block *K*, the holes for the studs which connect the block with the half-nut are recessed, and springs interposed between the heads of the screws and the bottom of the recesses of the block. The springs keep the screw *G* ordinarily in engagement with the half-nut, but when pressure is applied downward on the end of the screw, the springs will permit it to be brought out of engagement with the nut.

Another interesting feature is introduced in the washer between the nut on stud *B* and the head *A*. In order to prevent the block *D* and bracket *E* from falling when the nut on the stud is unscrewed, a key is put through a slot in the stud; the ends of this key rest on the washer *L* as shown. On top of the key another washer, provided with a groove to accommodate the key, is placed. The key is tapered and at the large end the slot in the upper washer is not carried completely through, in order to prevent the key from slipping out of its seat accidentally.

The vertical adjustment of the spindles is accomplished by means of threading the outside of the sleeve *C* and having it engage with a thread in the vertical hole for the bushing in block *E*. The drill spindle *F* is held firmly by shoulders to the bushing *C* in the longitudinal direction, but, of course, is free to rotate in the sleeve. When the sleeve is adjusted in the bracket, the spindle consequently follows, and thus an independent vertical adjustment is obtained.

While reference has been made especially to the application of this device to a multiple spindle drill press, it is evi-

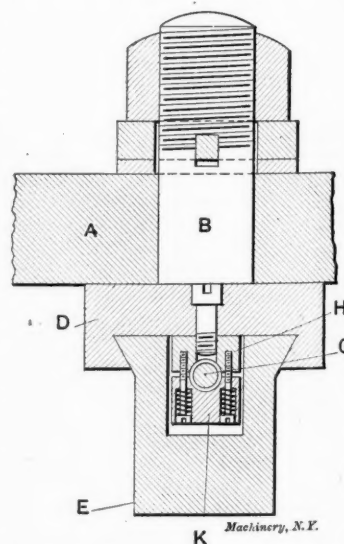


Fig. 3. Section through Half-nut, Screw and Spindle Guiding Bracket.

dent that this is only one example of the utilization of the device, and that it is not limited to the type of machine here shown.

### THE "RADICAL" ANGULAR DRILL.

The Radical Angular Drill Co. of 114-118 Liberty St., New York City, is introducing in America a tool for drilling square, triangular and other polygonal holes. It has been used for some time in Germany and other European countries. While this tool resembles all the others of its class, in its general construction, it has some special features which the inventor

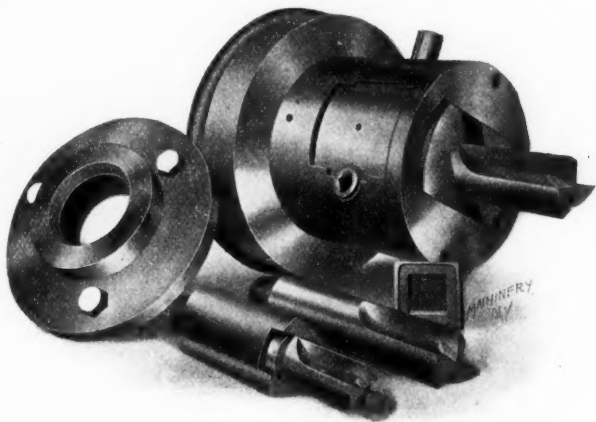


Fig. 1. A Device for Machining Square Holes, with Sharp or Round Corners.

claims are original and have never before been employed. The most important of these features is the provision made for cutting holes with absolutely flat sides and sharp corners. The device is at least theoretically capable of doing this, and the only theoretical considerations in the way are the matter of accuracy of workmanship, and sharpness and correct form of cutting tools.

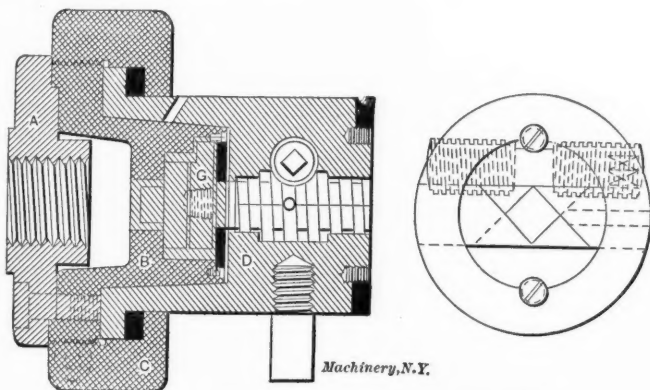


Fig. 2. Construction of the Angular Drilling Attachment.

Fig. 1 shows the device with one of the cutting tools in place, and others lying beside it. An axial section through the attachment is shown in Fig. 2. Flange or face plate A is screwed onto the nose of the machine in which the work is to be done. This may be either a lathe, drill press, milling machine (see Fig. 6) or any other tool having the necessary rotary spindle and means for holding the work. To flange A is screwed the driving member B. Over this is fitted the chuck D which is held in place on B by nut C. This chuck is similar to the common design used for drilling chucks, and is provided with jaws operated by right and left-hand screws which give a square opening, as shown in the end view. This member is stationary, being fastened in some way to keep it from revolving. The size of the square opening, in connection with the tool used, determines the size of the square hole to be drilled. If a triangular hole is to be drilled, special jaws which give a triangular opening are provided. The tool itself, seen better in Fig. 3, is composed of the three-lipped cutting blade and a holder. The latter is screwed into the dog G which is driven from B in such a way that the tool is positively rotated, but allowed to float as required by the peculiar contour of the holder, in

connection with the square opening in the jaws of the chuck. These jaws are tightened down so as to just fit the holder or shank, and still allow it to rotate.

The action in cutting a square hole will be understood from Fig. 4. The line marked *d* represents the square opening in the chuck jaws. The line marked *f* is the outline of the

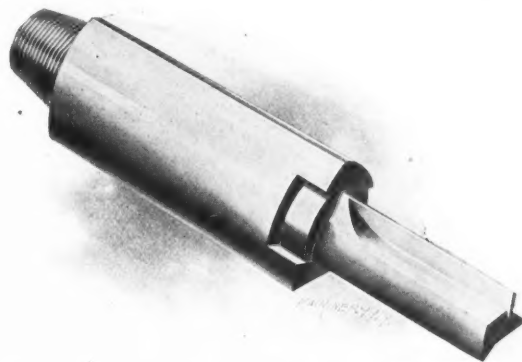
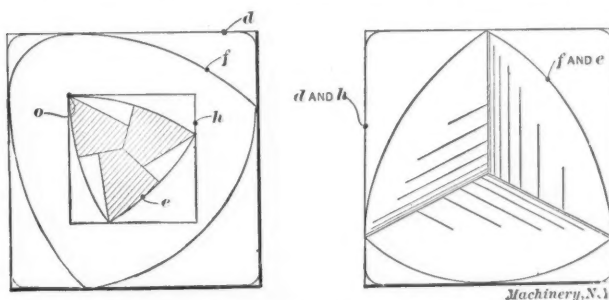


Fig. 3. The Cutting Tool and Shank used for Sharp Corners or Round Holes.

shank of the cutting tool. The hole being cut is shown at *h*, and *e* is the cutting blade. It will be seen that the action of *f* in *d* is identical with that of a familiar form of cam sometimes called a "3-cornered box cam." The particular construction which makes it possible to cut geometrically square corners lies in placing the center of the rounded one of the three corners of *f*, at *o*, which is exactly in line with one of



Figs. 4 and 5. Sketches showing the Principles of Drilling Square Holes with Sharp and Round Corners.

the cutting edges of the tool *e*. This means that this one of the three cutting edges of the tool finishes the periphery of the square hole. It is led in straight lines, parallel with the sides of *d*, and at each corner is pivoted about itself, leading out at right angles to its entering direction.

A construction previously used for cutting a square hole (see Fig. 5) involves the use of a shank *f* working in opening

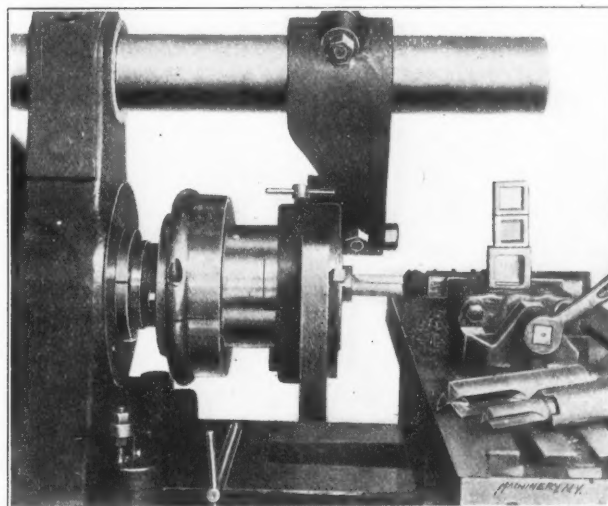


Fig. 6. The Attachment in use on the Milling Machine.

*d*, and guiding a cutting tool of exactly the same size and outline as *f*. In this case, while the sides of the hole produced (which is the same as *d*) are thus straight, the cutting edge of the tool does not cut clear in to the sharp corner, and slight fillets are left as shown. When it is desired with this attachment to cut square holes with small fillets, the

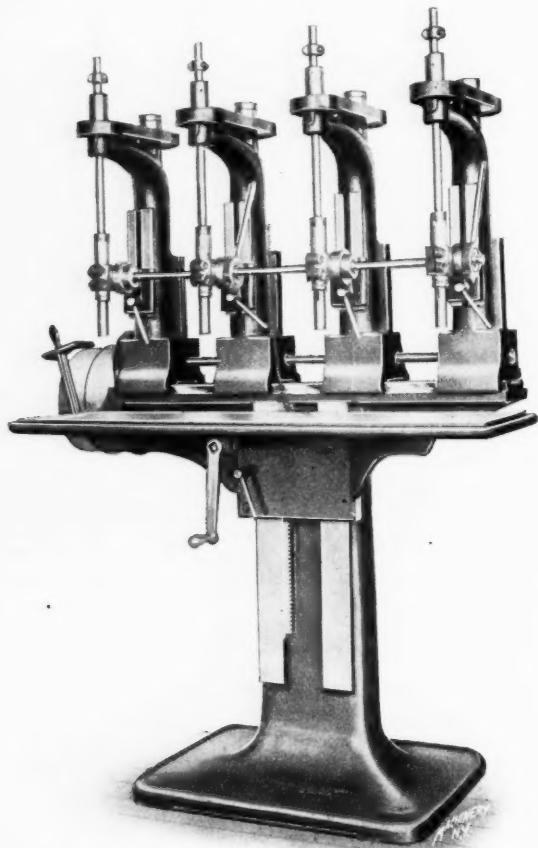
shank and tool are made of the same size and the shank is given the form shown at *f* in Fig. 5. The cutting of three-cornered and six-sided holes is effected by tool shanks and cutting tools of suitable outline working in special chucks. These have slight fillets, though it is almost impossible to discern them in the case of the hexagonal hole.

The grinding of the tools may be effectively done by means of a simple attachment provided by the makers. This attachment locates the tool by the corners of the shank in a V-block, which is set at such an angle as to present the cutting edge properly to the grinding wheel in a surface grinder, cutter and reamer grinder, or other similar machine.

In using this device in a machine spindle, a stop bar may be screwed into the chuck *D*, and rested against some stationary point, such as the frame of the machine. The angular position of the stop bar about the axis of rotation, of course, determines the angular location of the outline of the hole. Fig. 6 shows the tool in use in a milling machine. Here, the chuck is kept from revolving by a clamp ring which encircles it, and is attached to the overhanging arm. Samples of the work done by the tool, and samples of the tools themselves, both for sharp-cornered and round-cornered square holes, are shown on the machine table.

#### IMPROVEMENT IN SENSITIVE MULTIPLE SPINDLE DRILL PRESS.

The accompanying half-tone illustrates an improvement added to the regular line of sensitive multiple spindle drill presses manufactured by the Taylor & Fenn Co., Hartford, Conn. The feature of the improvement is that all the spindles can be fed simultaneously to the work by operating a single handle, the feed pinions having been connected with one another by means of a splined shaft running through to



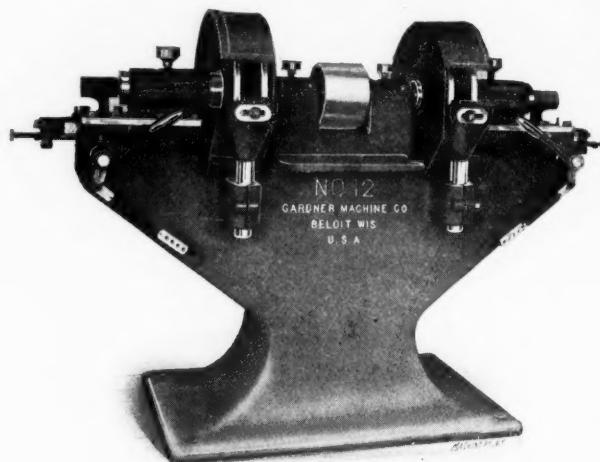
Taylor & Fenn Sensitive Drill Press arranged to Feed all the Spindles by Operating One Feed Handle.

all the spindles. Of course, a feed lever may be applied at every spindle, and any feed lever may be operated for feeding all the spindles towards the work. This arrangement does not interfere with the adjustable feature of the various spindles. By simply releasing the keys in the hubs of the feed pinions, the connecting shaft may be disconnected at any time so that the spindles may be used independently.

This type of machine is built with any number of spindles up to six. As shown in the photograph the top columns are placed at equal distances apart, but they can be adjusted to any distance from one another, whether evenly or irregularly spaced. It is evident that for drilling a large number of duplicate parts, the arrangement permitting the feeding of all the spindles by one handle, is of great advantage, and that the rapidity with which the work can be performed is much greater than in the ordinary form of this machine, where each spindle must be fed to the work independently of the others. In all other respects, the machine is of the same design as those regularly manufactured by the Taylor & Fenn Co.

#### NO. 12 GARDNER IMPROVED DUPLEX DISK GRINDER.

In the July, 1908, issue of MACHINERY, a double disk grinder manufactured by the Gardner Machine Co., Beloit, Wis., was illustrated and described. The accompanying half-tone shows what is practically the same machine, but built in a double pattern, so that there are, in fact, two machines mounted



No. 12 Gardner Improved Duplex Disk Grinder.

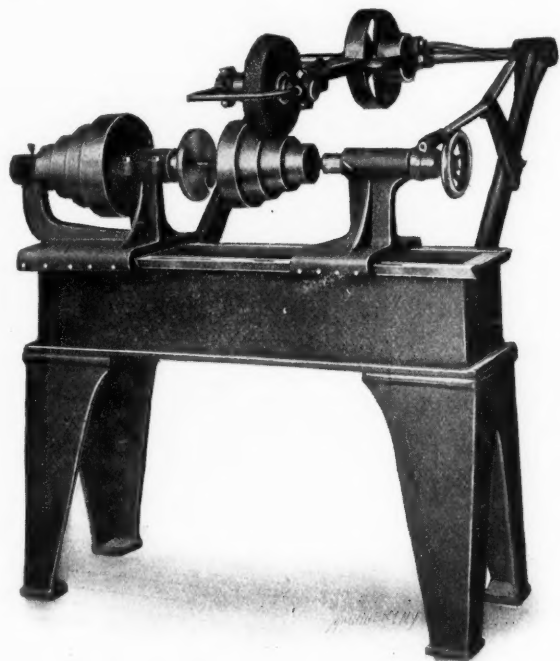
on the same frame. It may either be used by two men simultaneously or by one operator rough grinding with the one pair of wheels and finishing with the other set. The same principle of driving by a single pulley as described in the July issue, is employed in the present machine. The outer disk wheels are mounted on hollow spindles supported on sliding heads; and driving shafts, coupled to the main spindle, drive the hollow spindles, the former being splined to engage with keys fastened in the latter. The lubricating arrangement is particularly well adapted to the purpose of the machine, and dust caps and other provisions for excluding dust from all wearing surfaces are provided. Disk wheels from 15 to 18 inches diameter may be used. The maximum distance between the wheels is  $4\frac{1}{2}$  inches, and the weight of the machine as illustrated is 1,900 pounds. With all accessories, including setting up press for the wheels, counter-shaft, splines, etc., and crated for domestic shipment the weight is 2,500 pounds.

#### HOEFER CONE PULLEY POLISHING MACHINE.

The machine shown herewith is one of a number of special machines which were originally developed by the builders in the manufacture of drill presses and metal power saws. The particular purpose of this machine is the polishing of cone and driving pulleys. It is intended to take the place of the more tedious and costly hand methods of polishing these parts. As shown, the machine consists essentially of a power-driven head-stock and a tail-stock, mounted in a way somewhat resembling the speed lathe. At the back of the lathe is mounted a round horizontal bar on which loosely revolve two pulleys, the smaller of which is connected with the counter-shaft, while the larger one is belted to an emery wheel. This wheel is carried on a swinging arm, also pivoted about the rod at the back of the machine. The arm has a sliding

motion on the rod, which is controlled by the lever at the right. The emery wheel is beveled, and swivels about an axis at right angles to the sliding bar, so that it may be set to agree with any taper for the crowning of the pulley.

In order to dispense with the time lost in putting pulleys on an arbor, a very satisfactory substitute for this method of holding them was designed. A conical plug is used, supported in the end of the spindle, instead of the regular cen-



A Machine for Finish Grinding Cone and other Pulleys.

ter. It is made of such size that it will take care of two or three different diameters of holes. This centers the pulley properly. To drive the pulley, a dog is placed on the face-plate, engaging one of the spokes in the work. In the tail-stock an auxiliary conical bushing, revolving on the regular center, gives proper bearing for the rear end of the hub. This tool has greatly reduced the time of polishing pulleys over the old methods, in the shops of the builders, the Hoefer Mfg. Co., Freeport, Ill.

#### FOOTE-BURT NO. 24 HIGH-DUTY DRILL.

The accompanying illustration shows a drill of the heavy, box column, high-duty type, built by the Foote-Burt Co., St. Clair Ave. and 41st St., N. E., Cleveland, Ohio. This size of machine was designed to use a 1 $\frac{3}{4}$ -inch high-speed drill to the full limit of its capacity in the hardest materials. An improvement over the usual construction of this type of machine relates to the provision of a single speed pulley drive, all the speed changes being obtained by the manipulation of the handles shown at the side of the column, which are within easy reach of the operator at all times. Spur gears are used throughout, except for one pair of slow running 2 to 1 bevel gears at the driving end, and one worm and worm-wheel for the feed.

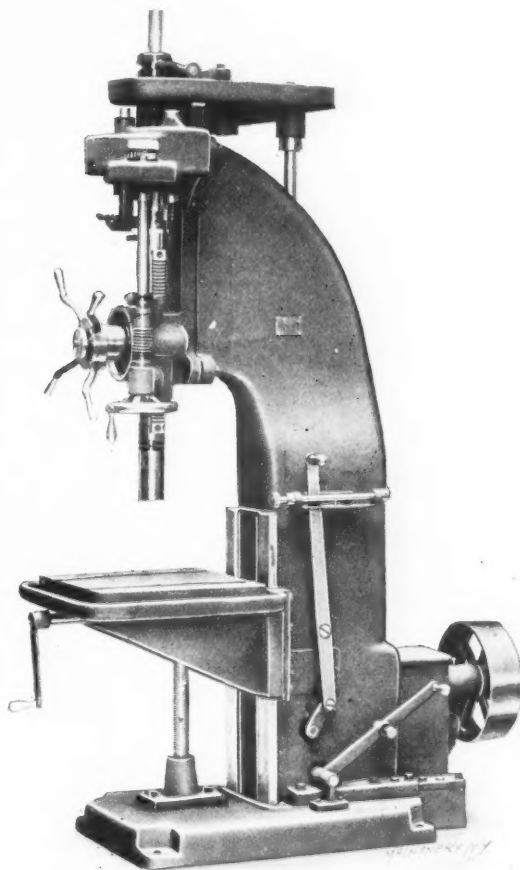
The spindle is of forged high-carbon steel, fitted with ball thrust bearings made by the builders of the machine, and guaranteed not to crush under severe duty. Three changes of geared feed are provided for this spindle, any one of which is instantly available by the simple shifting of a lever at the front of the machine. This feed change can be made without stopping the spindle. An adjustable automatic stop and a hand throwout is provided. The hand feed is through the worm gearing shown; the quick traverse in either direction is accomplished through the spider hand-wheel at the front of the machine, which engages or disengages the feed connection by an in or out movement of any of the handles. The table is of the knee type, with a large square locked bearing surface on the vertical ways of the column, to which it is securely gibbed. It is adjustable vertically by a square thread screw, located just back of the center of the table, to permit boring a hole through the latter for pass-

ing boring bars or other tools, if desired. The work is clamped to it by means of the two T-slots provided, and it is surrounded with a liberal oil groove.

The driving and speed change gearing is mounted at the base of the column. The nine spindle speeds are obtained through a double train of spur gearing, which is always in mesh and runs in a bath of oil. There are two sets of three gears, any one of which in each of the two trains may be thrown into action by a sliding lock bolt or key. The three speeds obtained in each of these trains give nine speeds in all, any one of which are instantly available. The power is transmitted from the horizontal shaft of this speed mechanism, through bevel gears inside the column, to a vertical driving shaft, which is connected with the spindle by an idler spur gear, thus avoiding the necessity of more than one pair of bevels in the entire machine.

A tapping attachment will be furnished, operated by a positive steel clutch located on the idler gear at the top of the machine, thus obviating the necessity for driving the spindle through the keyed member of a clutch. This attachment reverses in the ratio of 2 to 1.

This machine has the following dimensions: The distance from the center of the spindle to the face of the column is 12 inches. The maximum distance from the nose of the spindle to the top of the table is 28 inches; the length of power feed is 16 inches; the spindle has a diameter of 3 inches at the nose, and is provided with a No. 4 Morse taper. The spindle driving gear is 8 $\frac{3}{4}$  inches in diameter with a 1 $\frac{1}{2}$ -inch face. The table has a vertical adjustment of 20 inches.



High-duty Drilling Machine with Single Speed Pulley Drive.

The nine spindle speeds range between 71 and 306 revolutions per minute. The three feeds are 0.007, 0.016, and 0.033 inch respectively. The net weight of the machine is 2,450 pounds.

As an extra attachment, a compound table will be furnished, with a knee specially built for supporting it. This compound table has a longitudinal adjustment of 14 inches, and a cross adjustment of 8 inches. The working surface is 16 $\frac{1}{2}$  x 30 inches. When the compound table is furnished, the maximum distance from the nose of the spindle to the top of the table is decreased by 3 $\frac{3}{4}$  inches.

**LODGE & SHIPLEY HEAVY AXLE LATHE.**

The axle lathe illustrated herewith is built by the Lodge & Shipley Machine Tool Co., Cincinnati, Ohio. The machine is of the standard construction, so far as its general plan is concerned. That is, the axle is driven by equalizing dogs from a hollow revolving driving gear at the center of the bed, the work being supported on two dead centers. Both journals may thus be turned simultaneously. Power is transmitted to the driving gear by a shaft lying in the center of the bed.

oiling bearings, and all the gearing is of steel. The driving shaft is of large diameter and is amply supported by journal blocks in the bed. There is no over-hanging on the pinion which engages with the main driving gear, as the shaft is

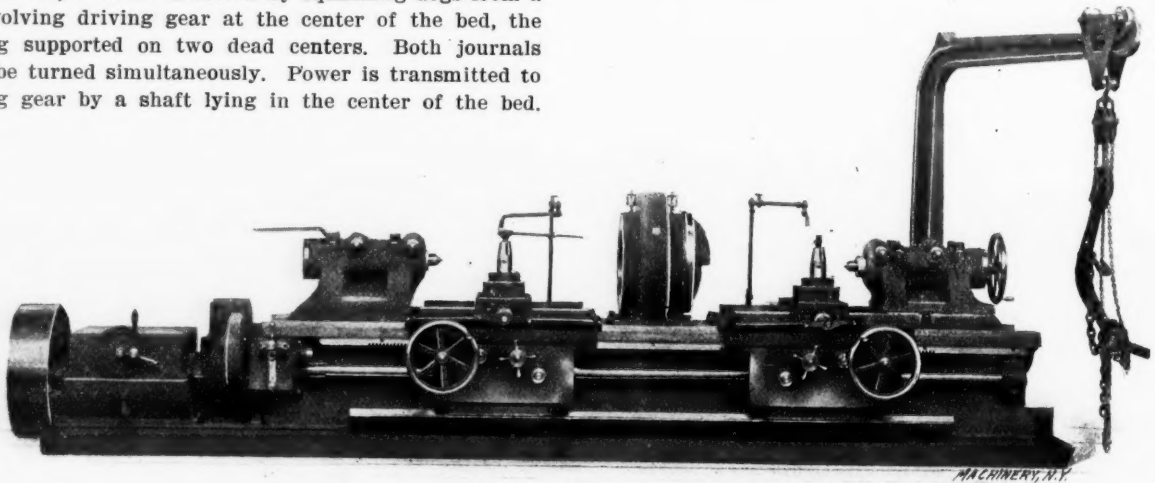


Fig. 1. Lodge &amp; Shipley Single Pulley Drive Axle Lathe.

In the details of its design, this lathe is original throughout and is intended to mark a new step in the development of special machinery for this class of work. Essentially this tool is another evidence of the growing tendency to provide

supported at each end in long bearings; the driving gear is also provided with a double bearing. The compensating driver, secured to the gear in the head, is provided with steel faced driving dogs.

All the feed gearing is of steel. The rate of feed is changed by the gear box shown, attached to the left-hand end of the bed; this gives three rates, which may be changed while the lathe is in operation. The two carriages are of unusually interesting construction, as is shown in Fig. 4. It will be seen that they are of the double walled type, this construction being more completely carried out than in any lathe apron that has ever come to our notice. The apron itself is of box form, entirely enclosing the mechanism, front and back, except for the necessary open-

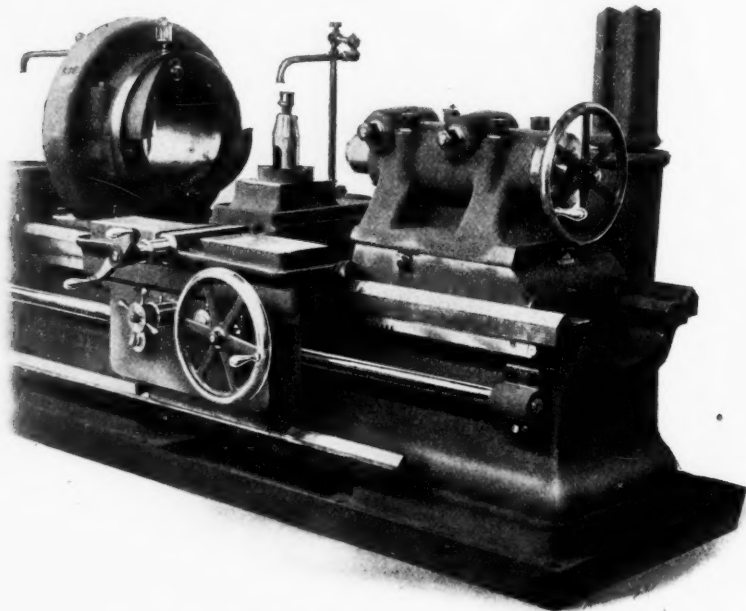


Fig. 2. Driving Head, Carriage and Tail-stock.

the heaviest machinery with all possible facilities for rapid manipulation. This tendency has, of course, been brought about by the remarkable shortening in cutting time made possible by modern high-speed steels.

The bed is deep and heavy, as may be seen. It is provided with frequent cross braces of box section, and has, as well, a longitudinal stiffening member, also of box section, cast in the center of the bed for its full length. The ends of the bed are cut away so as to facilitate the removal of the tail-stocks, or to permit them to over-hang for a reasonable amount, on work of unusual length.

An especially important feature of this machine is the drive. This is best seen in Fig. 3, which shows the gearing in the speed box exposed, with the cover removed. Power is applied to the constant speed pulley of large diameter and wide face, running at high velocity. The three speeds are obtained by sliding gears, running in a bath of oil; this number is sufficient to cover the range required for the work of turning axles. All the shafts are carried in bushed, ring

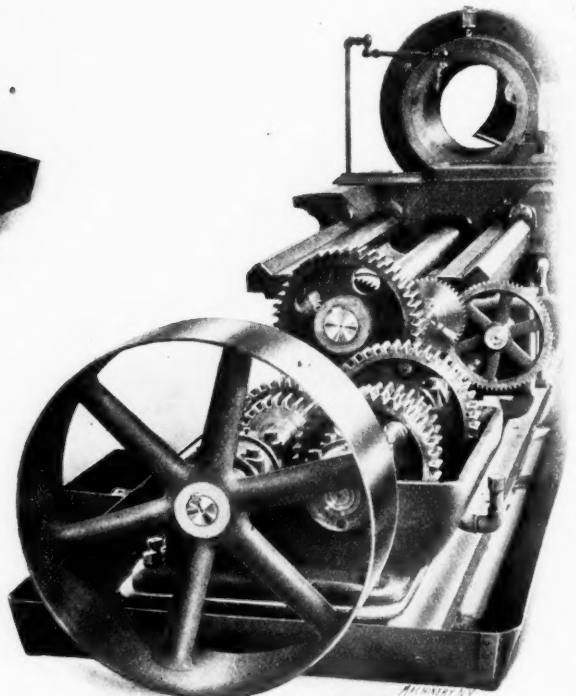


Fig. 3. Driving Gearing with Cover Removed.

ings. This gives great power and durability to the feed mechanism, and should enable it to withstand the rough service to which lathes of this type are inevitably subjected.

The particular point of interest in the design of the carriage relates to its support by a third V, cast in the bed directly under the apron. This is best shown in Fig. 2. A tapered gib is provided for this bearing, which may be set so that the carriage is supported evenly on all three V's. The purpose of this construction is to support the apron at the bottom for both vertical and transverse stresses. The spring of the apron due to the thrust from the rack and pinion is thus effectively overcome. The carriage itself has a bearing on the flat way at the front side of the bed, on which the tail-stock slides, as well as on the V's at the front and rear. This bearing is carried over the 45-degree surface on the inner edge (seen at the end of the bed in Fig. 2). This, with the V's, furnishes sufficient provision against the heavy thrust that results not only from the cutting, but from the operation of burnishing as well.

Water troughs are provided around the tool slide and the wings of the carriage. The tool-posts are arranged with hard-

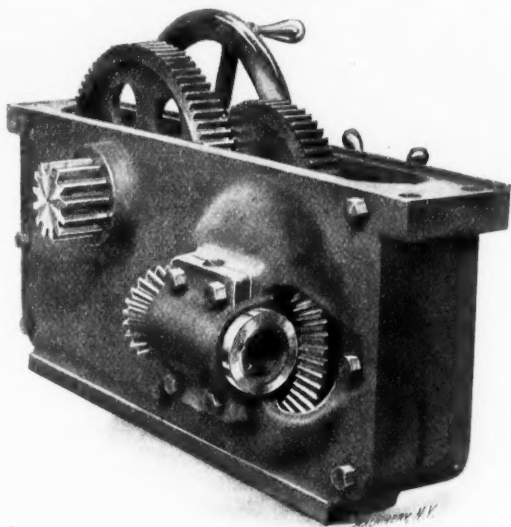


Fig. 4. An Apron that is really "Double Walled."

ened toothed plates interlocking with the tool, and effectually preventing the possibility of its swinging or slipping under the heaviest cuts. The tool slide itself is of steel.

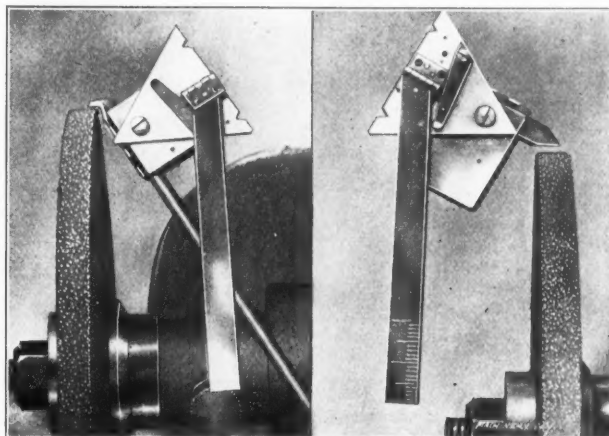
The tail-stocks are of heavy construction, clamped to the bed by four bolts as shown. These are brought to the top of the spindle barrel, where they can be easily operated from the working position at the front of the machine. The common arrangement, found on heavy lathes, of a pawl for the tail-stock engaging a rack cast in the bed is provided in this case. This arrangement tends to relieve the strain on the clamping bolts, and makes the locking of the tail-stocks positive against the strain of the heaviest cut. The tail-stock at the driving end has no cross adjustment. That at the right-hand end may be adjusted for aligning the centers to parallelism, or for turning tapers. The spindles of each tail-stock are clamped by two plug clamps of improved design. They are placed on top of the spindle barrel where they can be easily manipulated.

Altogether this lathe gives the impression of being a very creditable piece of design.

#### KRIEGER GRINDING GAGE FOR THREAD TOOLS.

The accompanying half-tone illustrations show the use of a 60-degree inside and outside thread tool gage brought out by the Krieger Tool & Mfg. Co., 83-91 Randolph St., Chicago, Ill. This gage is intended to guide the operator in sharpening threading tools made from flat stock or in grinding the point of forged inside thread tools. It is well known that it is difficult to grind a 60-degree thread tool with any degree of accuracy when one is simply guided by the eye for judging the angles of the tool itself. By the use of this grinding gage it is possible with little experience to get a 60-degree angle so nearly perfect at the first grinding that no regrinding to a more correct angle will be necessary. This length-

ens the life of the tool and saves time. The gage is also provided with a center gage so that the angle of the thread tool may be tested directly in the gage. The lever or arm extending from the gage and by means of which the operator gages the angle at which he holds the gage, is graduated with ordinary rule graduations, and the tool consequently makes a handy combination tool. Spring clamps are pro-

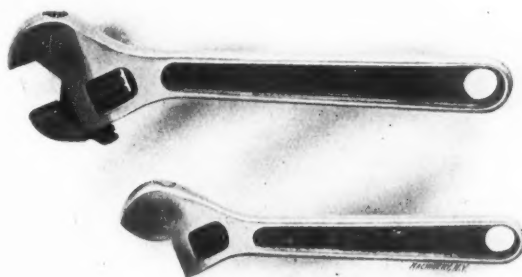


Figs. 1 and 2. Grinding Internal and External Thread Tools, using Krieger Grinding Gage to obtain Correct Angles.

vided by means of which any tool is easily attached to the gage. In the illustrations, Fig. 1 shows the grinding of an internal thread tool, and Fig. 2 the grinding of a 60-degree external thread tool from flat stock. These illustrations indicate the manner in which the operator is guided by the arm of the device so as to see that he holds the tool in approximately the correct position when grinding, the arm then being parallel with the wheel.

#### CRESCENT ADJUSTABLE WRENCH.

The accompanying half-tone engraving illustrates the Crescent adjustable wrench made by the Crescent Tool Co., Jamestown, N. Y. In the designing of this wrench the outlines of the ordinary 22½-degree engineer's wrench, which is acknowledged to be the most serviceable of all solid wrenches for practical use, has been followed. The design is such that the wrench can be used in practically every opening where a solid wrench can enter, but one size of this adjustable wrench takes the place of a great number of solid wrenches; thus, the 10-inch wrench, which is the larger of the two shown in the engraving, replaces nine sizes of solid wrenches. The wrench consists of five pieces: the handle with one of the jaws forged



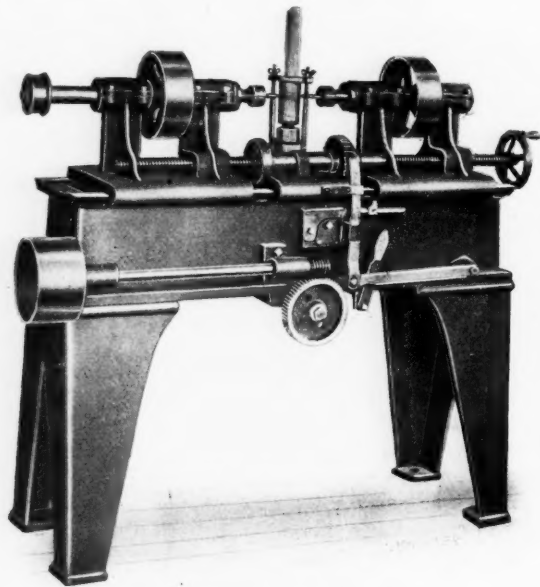
Two Sizes of Crescent Adjustable Wrenches; the Closed and Opened Wrenches are 8 and 10 inches, respectively.

solid with it, the adjustable jaw, the thumb screw by which this jaw is adjusted, a pin or stud, and a spring. The movable or adjustable jaw is provided with ample bearing surface in the handle and when in use locks itself against the handle, thereby relieving the thumb screw of the working stress. A small spring washer is placed between the thumb screw and the handle at the upper end of the former. This acts as a friction and prevents the thumb screw from moving too easily and changing the adjustment of the jaws, if the wrench should be laid carelessly on the bench or floor. It will be noted that the opening between the jaws is easily adjusted to fit the nut, with the thumb of the same hand that holds the

wrench. The handle is made from drop forged carbon steel and the movable jaw from special alloy steel. At the upper end of the handle a hole is provided by which the wrench may be hung on a nail.

### HOEFER SPLINING MACHINE FOR CROSS SLOTS IN SPINDLES.

Like the Hoefer cone pulley polishing machine described in this issue, this machine for milling cross slots in the ends of spindles, is the result of the needs of the Hoefer Mfg. Co., of Freeport, Ill., in its work of building vertical drill presses and power metal saws. This tool is entirely automatic in its



Machine for Automatically Cutting Drift Pin Slots, etc.

action, and is extremely rapid, it being unnecessary to pay any attention to it except to change spindles when the work is completed.

The machine consists of a bed on whose upper surface are mounted heads carrying the cutter spindles, between which is vertically reciprocated a work spindle on which the part to be machined is mounted. The heads are strongly made, and are rigidly gibbed to the ways on the top of the bed, and are connected by right- and left-hand feed screws journaled in the work spindle head at the center of the machine. The rotation of this screw simultaneously feeds the cutters in toward or away from the work. The connection between the two ends of the lead-screw is by friction couplings, which allow the two heads to be adjusted independently for depth.

The cutter spindle at the left carries a pulley, belted to another on the shaft at the front of the bed, by means of which the feeding and operating movements of the machine are controlled. This shaft, through worm gearing, drives an adjustable crank, which reciprocates the plunger spindle on which the work is mounted. By means of the adjustment of the crank-pin, drift holes of various lengths can be obtained. The spindle to be milled is held firmly and solidly by means of the clamps shown, on a taper plug fast in the plunger. This provides the means for holding the work and reciprocating it vertically to agree with the length of slot to be milled.

The feeding of the heads inward at the end of each stroke of the work, is effected by means of cams on the inner face of the worm-wheel. These operate on the lever shown, which is in turn connected with the vertical pawl, engaging a ratchet wheel on the right- and left-hand feed-screw. This ratchet feed is automatically thrown out when the proper depth has been reached, by the striking of a pin on the left-hand head against an adjustable release dog controlling the movements of the pawl. It may also be thrown out by hand, by operating the short lever seen at the bottom of the bed, which raises the mechanism beyond the reach of the operating cams. A very thin shell is left between the cutters at the conclusion of the action. To remove this shell the two ends of the feed-screw

can be separated as described, and one head alone used in cutting it out.

The accuracy of the work is insured by the alignment of the heads on the bed, and by the firm support given the fish tail cutters. The bed carries an oil tank and an oil pump, which furnish a steady stream of oil to the cutter.

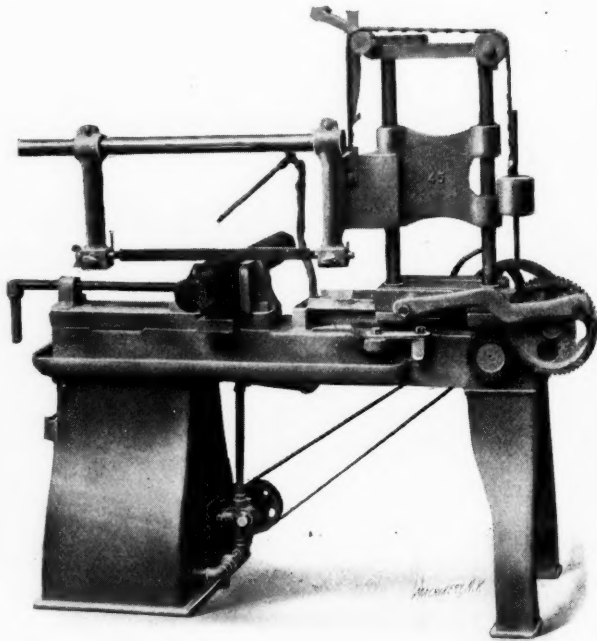
### HIGH-SPEED "STERLING" HACK-SAW MACHINE.

The Diamond Saw & Stamping Works of Buffalo, N. Y., has recently placed on the market two new power hack-saw machines, known as No. 3 and No. 4 high-speed "Sterling" power hack-saws. The No. 3 machine is illustrated in the accompanying engraving. These machines take blades from 17 to 21 inches in length and can be run at a speed of from 80 to 100 strokes per minute.

The main driving shaft on which the pinion driving the gear for the saw frame motion is fastened, is 17/16 inch in diameter, and the large gear shaft is 13/16 inch. The bearings are thus large in diameter, and have also been given sufficient length so as to eliminate rapid wear. The area of the working surfaces of the main bearings, in fact, is 8 square inches. All bearings are provided with means for taking up lost motion with the exception of the main driving shaft bearings, where this has not been considered necessary. The drive is by means of tight and loose pulleys, and a pump for lubrication is provided so that oil or other lubricant can be used on the saw when running at high speed. The front leg of the machine is made with a cabinet frame and a tank for the lubricant is provided inside of the leg.

The construction of the saw frame and the means for counter-balancing are plainly shown in the engraving. The vise for holding the work is provided with a swivel base so that work can be cut off at any angle up to 45 degrees. The limiting capacity of the machine is 8 x 12 inches.

The No. 4 machine is identical with the No. 3 machine excepting that instead of the solid vise provided in the ma-



High-speed Hack-saw Machine made by the Diamond Saw and Stamping Works.

chine just described, the No. 4 machine is made with a centralizing vise and provided with adjustable stroke which enables the operator to use every part of the blade. When much small work is cut off, a certain portion of the blade only is utilized if the stroke is not adjustable, and therefore in shops where there is a large amount of cutting off to be done and the machine is almost continuously in operation, the saving in cost of blades due to the use of an adjustable stroke will soon amount to a considerable figure. It is estimated that from one-third to one-half of the amount of saw blades used can be saved when small work is being cut off by an

arrangement which permits using every part of the blade, and the value of this improvement is therefore apparent.

### PRENTICE BROS. 16-INCH SHAFT TURNING LATHE.

Prentice Bros. Co., Worcester, Mass., is placing on the market a lathe of the type adapted to the turning of shafting, and especially for work having several diameters and shoulders. For this work, it is arranged with a carriage carrying a number of tool-holders, each of which is provided with a follower rest; and the construction of the tail-stock is such

adjustment screws, which shift the tool blocks on their dove-tail bases.

Each tool block is provided with a roller follower rest, whose use is largely responsible for the success of the machine. In Fig. 2, the left-hand tool block has the follower rest lifted up out of the way. To bring it into working position it is lowered, as shown for the other block, and is then pressed toward the right and forced under a ledge, which securely binds it in position. The fitting of these parts is so close that particles of dirt or chips will prevent the entrance of the rest under the ledge. The roll carriers may be fastened on either side of the follow rest, so that the

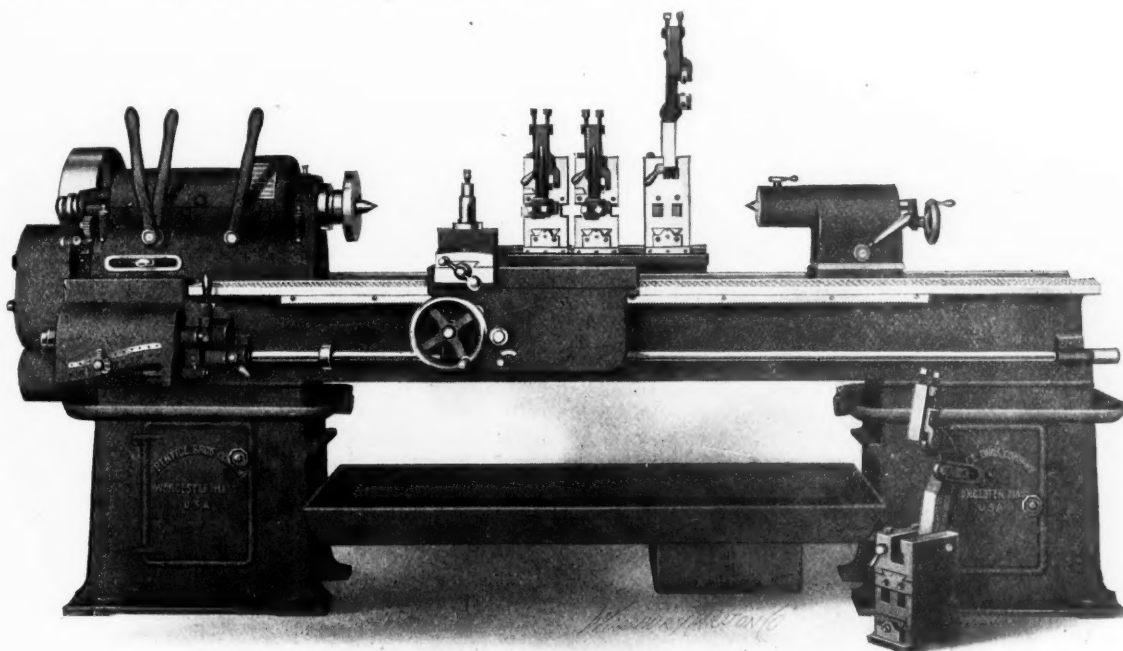


Fig. 1. New Design of Prentice Lathe, especially adapted to turning Studs, Shafts, etc.

that these can be run back beyond it, so that various diameters can be turned at one single passage of the carriage, without adjusting or shifting any of the tools.

The head-stock of this lathe (see Fig. 1) is the same as is used on the builders' regular high-speed geared-head lathes. The three levers at the front of the head-stock give eight changes of speed. These changes are obtained simply and conveniently, and with no possibility of error or mis-manipulation on the part of even the most careless workman. The use of a head-stock of this type gives the operator no excuse for not running the spindle at the proper speed for the diameter of work he is turning. The quick change gear mechanism is also the same as used on the makers' standard lathe, where it has proved itself to be entirely satisfactory. It is simple in construction and operation. As in the case of the head-stock it is impossible to lock any conflicting ratios of gears. The index plates accompanying the lathe clearly explain the operation of the levers.

The main point of interest is the carriage, which is shown in Fig. 2 with two tool blocks in place. It differs radically from the usual construction, in having, for one thing, the bridge at the left-hand end, with the bearing extending toward the right. This construction allows the tool blocks to pass back beyond the tail-stock. Another conspicuous departure from the usual construction will be noted in the fact that the tool blocks are at the rear of the lathe, so that (as the tools themselves, as shown in Fig. 2, are right side up) it is evident that the spindle runs backwards. The tool carriers or blocks are securely bound to the dove-tail on the rear bearing of the carriage, by means of three backing screws, which are reached from the front, and which hold it firmly in position. The cutting tools are held in slots in these blocks, by means of hardened steel taper wedges, which are brought into action by square end adjusting screws projecting from the block in front over each slot. For adjusting these tools for diameter, the same wrench as for tightening them is used on the cross

rolls may be brought to bear on the work directly following the tool cut. The right-hand block in Fig. 2 shows clearly that this construction virtually makes a box tool of each tool-holder. Each of these tool-holders is provided with a separate supply of oil, from piping at the back of the carriage.

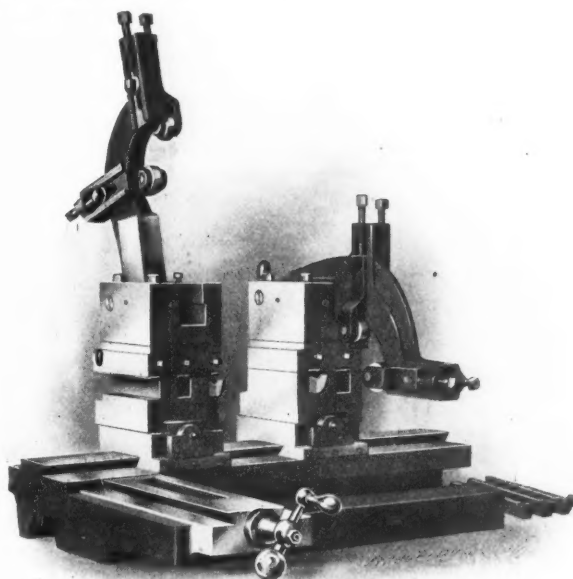


Fig. 2. The Carriage and Tool-blocks, with Follow Rests.

The tail-stock is shown plainly in Fig. 3. It is reversed from the usual construction, since the tool rests are required to pass it at the back instead of at the front. The clearance provided for the tools is unusually close, it being possible to set the latter for cutting down to 13/16 in diameter, and still pass them back of the tail-stock spindle for their

entire length. As may be seen, the spindle itself is of small diameter, and is grooved to permit the passage of the tool. When work is to be placed between the centers preparatory to turning, the tool carriage is run back toward the tail-end of the bed, so that the first tool will start in to cut at the end of the shaft. It is at this position that the tools must clear the tail-stock, especially when turning small diameters.

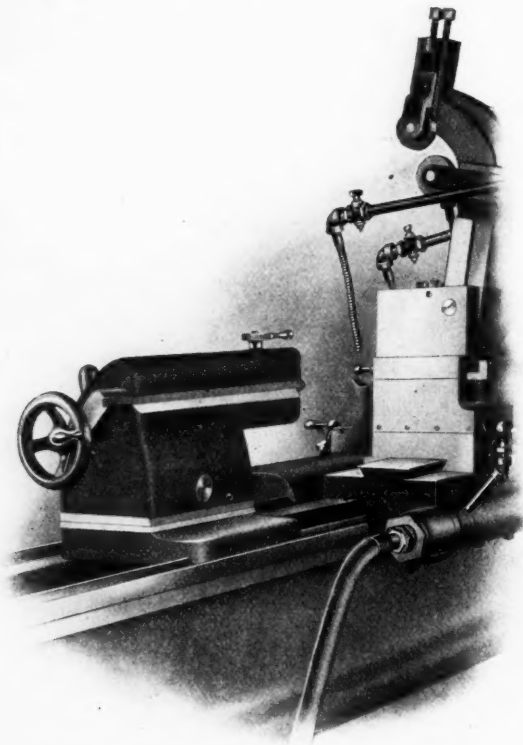


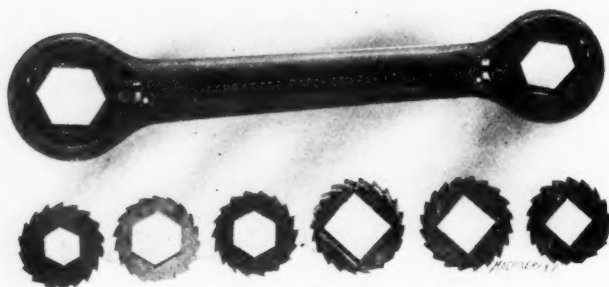
Fig. 3. Tail-stock cut away to clear the Tools.

The work for which this lathe is especially adapted is the turning of shafts and studs of all kinds, in the sizes found in the ordinary run of work in the average machine shop. Its field is thus seen to be a broad one. It is not intended ordinarily to be used for screw cutting, but at a small extra expense a lead-screw will be furnished; in this case the work of the ordinary engine lathe can be done on the machine, using the regular tool-post shown at the left-hand side of the carriage in Fig. 1. This tool-post is intended ordinarily to be used for squaring down shoulders, if the work requires this.

The lathe swings  $17\frac{1}{2}$  inches over the ways and takes 62 inches between the centers on a 9-foot bed. The largest diameter the follow rests will take is 5 inches. The net weight of the machine, with a 9-foot bed, is 3,300 pounds.

#### SCHROEDER RATCHET WRENCH.

The Bullard Automatic Wrench Co., Providence, R. I., has brought out a ratchet wrench provided with interchangeable disks to take square and hexagon standard size nuts, which



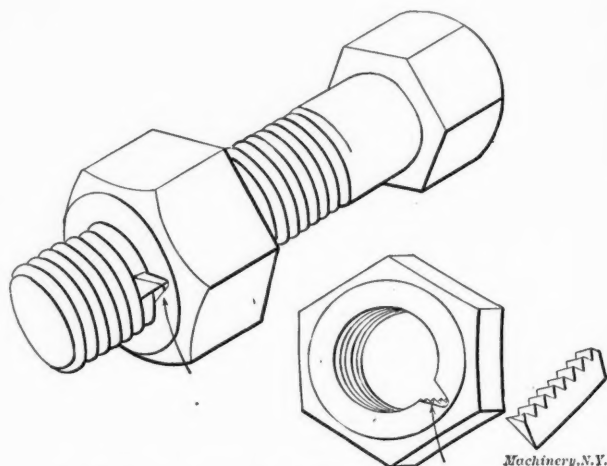
Schroeder Ratchet Wrench with a Full Set of Interchangeable Disks.

on account of its adaptability to a great many different conditions will undoubtedly be of interest to the trade. The main advantage is that one wrench handle will serve for seven or eight different sizes, and the change of disks,

permitting this wide range, can be made in less than one-half minute. The accompanying engraving shows the general design of the wrench and also a series of disks which can be placed in the wrench in place of those shown in position. The construction of the wrench is very simple. A pawl is provided with a spring behind its plunger so that it will be constantly in contact with the disks when in use. In the center of this pawl a thin key is provided which enters into a groove in the disks, thus holding them in place when once inserted. When it is required to change the disks, all that is necessary is to pull the pawl back as far as it will go and the disk will fall out. When in use, the pawl is forced over against the step on the side of the slot provided for it, and the wrench acts practically as a solid tool. The frame or handle is made double ended, as shown, of high quality steel, drop forged and case-hardened. The interchangeable disks are made of soft steel and all the holes are made to fit standard hexagon nuts, or a set of disks may be provided for five hexagon sizes and three square nut sizes. Besides these disks there is an extension piece provided with the sets, one end of which fits the half-inch disk of the wrench, and the other end taking any of the disks in the set. With this combination the wrench may be used in many otherwise inaccessible places.

#### VIBRATION LOCK-NUT.

A self-locking nut has recently been brought out by the L. S. Brach Supply Co., 143 Liberty St., New York. It is the invention of Mr. W. L. Clark, vice-president of the Niles-Bement-Pond Co. In view of its simplicity it will undoubtedly be of interest to practical men and appreciated in mechanical work. The principle of the nut, which is termed by its makers the vibration lock-nut, is shown in the accompanying line engraving. The nut is made like an ordinary hexagon nut, and has a V-shaped slot cut longitudinally on the inside of the hole, with a threaded wedge or key fitting



Self-locking Nut brought out by the L. S. Brach Supply Co.

into the slot, so as to form a part of the nut. This wedge is so shaped that it does not interfere with the running of the nut onto the bolt; but when the nut is reversed for removal, the key is carried over against the opposite side of the slot, its teeth being forced against the bolt so as to firmly grip it. This prevents accidental loosening of the nut. When it is required to remove the nut, however, this can easily be done by inserting a pointed wire, or any pointed object, in the larger opening on the side of the key before starting to turn backwards. This will prevent the key from getting into position to act as a binding wedge, and the nut is removed as easily as an ordinary nut.

It is clear from a study of the construction that the nut will lock itself securely at any point on the bolt without distorting or damaging the thread. It should be valuable wherever lost motion of the parts held is likely to occur, as it will hold firmly and indefinitely the parts it is required to secure. In fact, it is not only self-locking, but where the parts vibrate it is also self-tightening, inasmuch as the vibrations will move the nut onto the bolt, but the key or wedge

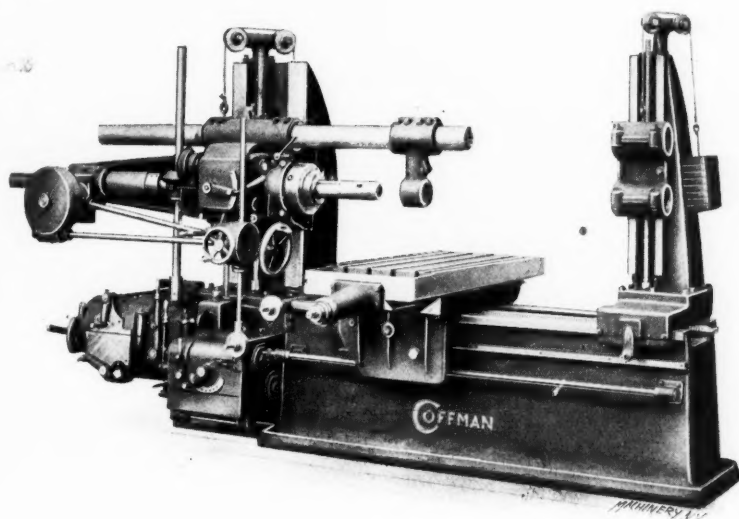
prevents the vibrations from moving it back to its original position. It is especially applicable for railway service on car trucks, fish plates, etc., dispensing with a large amount of inspection now necessary, and insuring safety at all times.

### COFFMAN UNIVERSAL BORING, DRILLING AND MILLING MACHINE.

The horizontal boring, drilling and milling machine shown herewith is built by J. P. Coffman, Franklin, Pa. This tool is unusually complete in the adjustments and movements furnished, and would appear to warrant the use of the word "universal," which is applied to it by the builders. An inspection of the two engravings will indicate some of the improvements incorporated in the machine. Note, for instance, the provision of an overhanging arm, and the bringing of both the fine feed and the quick traverse hand-wheels for the boring bar, close to the operator's position. Other features will be noted in the course of the following description.

#### General Construction.

The main bed is of the box type of design, and is heavily ribbed and cross-braced. The stiff form of the column will be appreciated from an examination of Figs. 1 and 2. The spindle head or saddle is counterbalanced, as is also the outboard support for the boring bar. The saddle and support are ad-



Coffman Universal Boring, Drilling and Milling Machine.

justed vertically by accurately cut screws, geared together, so that they always move in unison.

Mention has been made of the overhanging arm, furnished for supporting the boring bar. This is not only useful in an obvious way in milling, but in boring it makes it possible to use bars in work where a number of holes are to be bored in line; supporting the bar in the center overcomes the danger of chattering, which is likely to occur in such work. It will thus oftentimes avoid the necessity for a special fixture. It should be noted that the outboard support for the boring bar is also provided with a support for the overhanging arm. The outboard bearings are especially wide. This permits the use of double bushings for supporting the boring bars, thus materially stiffening them.

Main and supplementary work-tables are provided, the former having automatic power cross feed, and the latter having cross slide ways which permit the work to be clamped to it, and still follow the movements of the main table. The main table is provided with oil channels for carrying off oil and cutting compounds. A reservoir for these is provided in the base.

#### The Spindle and Driving Mechanism.

The machine is built on the unit plan of construction, with the speed box, feed box, spindle drive gearing and feed drive gearing as the principal members. The machine shown has a speed box for constant drive. This, however, may be replaced. If desired by the customer, however, a cone drive or variable speed motor will be furnished instead. If a con-

stant speed motor drive is to be used, the speed box is retained, and the driving shaft is directly connected by gearing or chain and sprocket with the constant speed motor. The speed change mechanism gives 12 rates of speed, there being four changes by a cone gear device, which is, in turn, multiplied by three positive change clutches. A reverse is also provided for in this box. In Fig. 2, handles *A* and *B* operate the cone gear change, while handle *C* operates the clutches. The reverse is effected by handle *D*, which controls a bevel gear and clutch directly on the vertical drive shaft of the spindle.

The lever *E* on the front of the spindle-head gives two rates of speed, and in the central position disconnects the spindle from the driving mechanism. The two rates of speed here obtained are in the proper ratio for the operations of boring and facing, and make it unnecessary to change the regular speed mechanism in performing these operations on a given-sized hole.

The nose of the spindle itself is provided with an internal split taper sleeve which, by means of a screw and socket wrench, may be forced in to clamp the boring bar for facing operations and similar work. When the bar is being fed through the spindle, it is tightened up just enough to give a firm bearing, thus obviating the looseness often resulting from wear at this point after long use. This clamping device also comes into play when holding milling cutters in the spindle. The spindle has a threaded steel nose-plate with a slotted face, adapted for holding the design of face mill that is screwed on with a spanner wrench and driven with a key. This permits running mills or facing heads positively in either direction.

The boring bar is of hammered crucible steel, ground and lapped true. The spindle is of semi-steel, provided with a long key or feather for driving the bar. The front sleeve bearing is taper and the rear one straight. Both are ground true and lapped, and run in bearings of "genuine babbitt" in which is set a spiral groove filled with rolled blocks of compressed graphite. Lubrication for these parts is effected from a reservoir in the bottom of the head.

#### The Feed Mechanism.

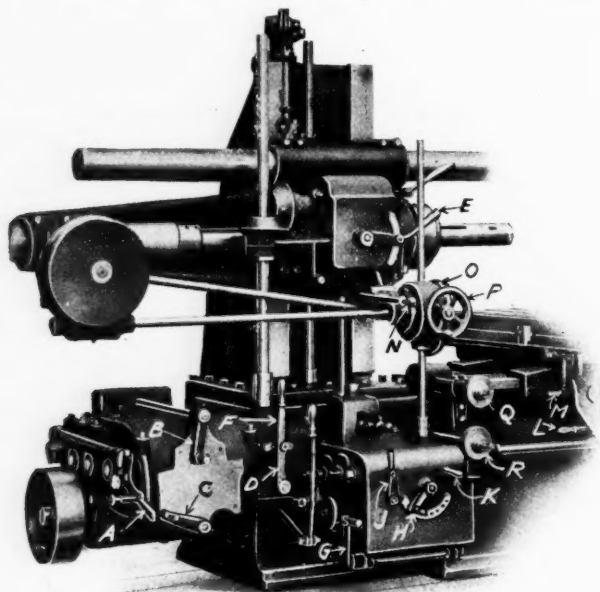
While not specifically so stated in the description furnished us, it seems safe to assume from the drawings and photographs furnished, that in this machine the feed is taken directly from the spindle, instead of from the driving mechanism. This gives the machine the same sort of feeding motion that is provided for the lathe and drill press—that is, one which varies directly with the spindle speed, and is stated as feed per revolution, instead of as feed in inches per minute. For all boring and drilling operations, this is a logical arrangement, though for milling the tendency more recently has been, of course, to provide a feed in inches per minute, such as would be given by regular millers provided with a constant speed drive. As drilling and boring operations will, under ordinary circumstances, constitute by far the greater work of a machine like this, the construction is a rational one. So far as our memory serves us, it has not been applied to any other boring machine of this type.

The feed, by means of one of the vertical shafts shown, is led down to the feed box at the front of the machine, where 21 changes are provided. This mechanism is similar in construction to that for the speed change. It is possible to operate either of them while the machine is in action. Levers *G* and *H* operate the gear cone mechanism, and lever *J* gives the reverse. The feed of the table and the boring bar, and the vertical feeds of the heads on the uprights, are all taken from this mechanism.

The bar feed is taken from a vertical shaft extending upward from the feed box as shown in Fig. 2. This feed is connected and disconnected by lever *K*. The motion is taken to the worm gear at the rear bearing for the boring bar. The hand-wheel *O* operates this movement, sensitively, by hand. By throwing lever *M*, the worm gear is disconnected from the

bar feed pinion shaft allowing a rapid movement to be effected by hand-wheel *O*. The cylinder rack sleeve form of feed is used for the bar. The rack is cut from the solid, and is of wide face and coarse pitch. The design permits the pinion to be brought near the center of pressure in the feeding, giving a decided advantage in drilling, or in spotting bosses with flat cutters.

The longitudinal adjustment of the table along the bed is effected by the square crank or index dial shown at *Q*. The power feed for the cross movement of the table is controlled by levers *L* and *M*. An automatic stop for milling is provided for this apparatus, the dog being adjustable in a slot on the front side of the table, as is usual for milling ma-



Enlarged View of End of Machine showing Operating Levers.

chines. The power elevating mechanism, controlling both the spindle head and the outboard bearing, is connected to the constant speed shaft so that it is not affected by the speed changes of the spindle. For sensitive adjustment by hand, the squared crankshaft shown at *R* is used.

#### Dimensions.

The boring bar is  $3\frac{3}{4}$  inches in diameter. It will feed 30 inches at one setting or 60 inches at a double setting. The front end of the bar is bored to a No. 6 Morse taper. The height from the center of the bar to the top of the table may be varied between 1 inch and 33 inches. The greatest distance available from the base of the spindle to the outer bearing is 78 inches. The working surface of the table is  $24 \times 48$  inches. It has a cross feed with automatic stop of 48 inches. The vertical feed of the saddle is 33 inches. The revolutions per minute of the bar may be varied in geometrical progression, in 24 changes, between 10 and 212 revolutions per minute. The geared positive feeds vary with 21 changes in geometrical progression between 0.004 and 0.500 inch to a revolution of the spindle. The net weight of the machine is about 11,000 pounds.

The design of this machine has been made, so the builders state, as nearly foolproof as possible, great care having been taken to insure it against breakage, and to insure the safety of the operator as well, by enclosing all parts. All the mechanism is accessible for inspection and repair. Dust-proof oilers are provided for all oil holes. Collar and shear pins are provided on all feed shafts, thus preventing injury to the driving mechanism in the case of running against a solid object with the vertical or cross feed. Particular attention should be called to the usefulness of the device as a milling machine. The provision of the overhanging arm, the wide range of feeds and speeds, the strong drive for the spindle, and the facilities provided for holding the cutter, as well as the cross feeds and automatic stop for the work-table, make this tool practicable and serviceable as a milling machine. It will be furnished by the builders, if desired, in the form of a

plain milling machine, as a plain boring or drilling machine, or (as in the case here shown) as a universal boring, drilling and milling machine—all from practically the same patterns.

**QUICK ADJUSTMENT PIPE WRENCH:** Webb & Hildreth Mfg. Co., Gloversville, N. Y. This wrench is intended for general use on piping, lugs, screws, etc.

**550-TON FLANGING PRESS:** Wm. H. Wood, Media, Pa. This press is intended for the heaviest flanging work. It is provided with one main ram, capable of exerting a pressure of 550 tons. An internal clamping ram for holding the work gives a pressure of 100 tons. Besides this there are four auxiliary cams, and another in the head.

**LIGHT PORTABLE DERRICK:** Parker Hoist & Derrick Co., 725 Old Colony Bldg., Chicago, Ill. This derrick is intended for general use in contracting and manufacturing plants. It is easily portable, and may be used either as a guy or stiff-legged derrick for steam or hand power. It is made in two sizes, having a capacity of 1,500 pounds and 4,000 pounds respectively.

**DRILL GAGE FOR GRINDING CORRECT LIP ANGLES:** Remington Tool & Machine Co., 50 Congress St., Boston, Mass. The drill to be measured lies in a V-groove with its point matching the angle gage, which is adjusted to the height of the drill point. By this means the drill may be ground to cut evenly on both lips.

**32-INCH PLANER:** Rockford Machine Tool Co., Rockford, Ill. This firm has just completed the first of a lot of new 32-inch planers. These are similar in design to the 24-inch size of machine described in the February, 1908, issue of *MACHINERY*. It is of much heavier construction, however, and will have two heads on the cross-rail and two side heads.

**No. 0 BACK-GEARED PLAIN MILLING MACHINE:** Owen Machine Tool Co., Dept. M., Springfield, O. The No. 0 milling machine built by this firm has recently been supplied with a back-geared drive, for taking feeds heavier than is usually possible with machines of this size. In other respects, the new design is the same as the plain machine.

**DIRECT-DRIVEN LEVER SHEAR:** Thomas Carlin's Sons Co., Pittsburg, Pa. This tool is driven directly from a crank on the driving shaft, without the use of intermediate gears, thus giving a high number of cuts per minute. The shear is especially adapted for cutting scrap, etc., of soft steel up to  $1\frac{1}{2}$  inch square. The knives are 8 inches long, and the approximate weight of the machine is 6,400 pounds.

**THREAD MICROMETER:** Ernest R. Seaward, 76 Campfield Ave., Hartford, Conn. This thread micrometer has an adjustable anvil which is set to agree with the required offset for the pitch to be measured. The line of adjustment is parallel with the side of the tool of a 60-degree thread. Formulas and readings for standard threads are stamped on the frame of the micrometer.

**MOTOR-DRIVEN PORTABLE DRILLING, GRINDING AND BUFFING OUTFIT:** Coates Clipper Mfg. Co., Worcester, Mass. This outfit is somewhat similar, though on a larger scale and for different uses, to the drafting-room outfit built by the same firm and described in this issue. The equipment includes a breast drill, old man, emery wheels, polishers, speed change device and so forth.

**METAL NUMBERING MACHINE:** American Numbering Machine Co., 291 Essex St., Brooklyn, N. Y. This firm's new Model P metal numbering machine is designed for stamping consecutive numbers on metal pieces, in the power or hand press. Indexing of the figures is done automatically. The speed of the device is limited only by the capacity of the operator. Any size or style of figures can be furnished.

**DUPLEX GRINDING MACHINE:** F. H. Otis, 191 Mill St., Rochester, N. Y. This grinding frame carries two others, one of which is provided with a water reservoir and splash pan for wet tool grinding, while the other has the usual rest for miscellaneous dry grinding, and is provided as well with a worktable beneath the wheel, accurately adjustable for height, and useful for surface grinding of dies and other such work.

**TAPPING MACHINE FOR LIGHT WORK:** John J. Grant, Cleveland, O. This tool is driven by a single belt, running over a three step cone pulley. The reverse belt for backing the tap out has been done away with, this movement being effected instead by gearing contained in the cone pulley. The machine is intended for light tapping, and is of the type in which the reverse is effected by endwise movement of the spindle.

**AIR COMPRESSOR FOR SHOP AND FOUNDRY SERVICE:** George H. Comstock, Mechanicsburg, Pa. This air compressor is of the enclosed two-cylinder, center-crank, single-action, belt-driven type. The main frame is a single casting, embracing both cylinders (which are water jacketed), the crank shaft bearings and the crank case. The cylinders are 4-inch diameter by 4-inch stroke, and will operate a 2½-inch chipping hammer or two smaller tools when running at 180 revolutions per minute.

**HEAVY QUADRUPLE CRANK PRESS:** E. W. Bliss Co., No. 5 Adams St., Brooklyn, N. Y. This machine is in reality composed of two double crank presses side by side, giving a press with a bed 154 inches long by 10 inches wide, and a correspondingly long slide. The adjustment of the length of the pitman is effected for all four cranks simultaneously, by means of bevel geared shafts operated by sprockets and chains from a driving shaft in the rear, which is in turn operated by power from tight and loose pulleys controlled by a belt shifter. The total weight of the press is over 36 tons.

**HYDRAULIC VARIABLE SPEED DRIVE:** Manly Drive Co., 17 State St., New York City. This form of variable speed drive employs a multi-cylinder pump as a driving member, with a similarly constructed engine as the transmitting member. The speed control is effected by varying the stroke of the pump plungers, thus furnishing a greater or less supply of fluid in gallons per minute to the motors. While especially designed for automobile or motor truck service, it should also be useful for other places where the variable speed device is required.

**22-INCH PLANER:** Cincinnati Planer Co., Cincinnati, O. This is the smallest planer ever built by this firm. Aside from being a new size, it incorporates some improvements in design, relating particularly to details. The shifting device is of new construction, designed with special reference to high speed and short stroke work. It is provided with a safety locking device, and is connected with a handle on the opposite side of the bed, so that the machine may be operated from either position. The crank adjusting handles are fixed in position, and are provided with revolving grips, so that the operator can retain a tight hold while turning the screw or rod rapidly.

**HYDRAULIC VALVE:** Caskey Valve Co., 422 Arcade Building, Philadelphia, Pa. This firm is selling a valve intended particularly for hydraulic service, though it may be used as well for steam or air. It is a plug valve, but is unusual in its construction, in that the plug is straight, instead of being tapered as usual. It is so constructed that the higher the pressure, the more tightly the valve is packed. This is done by introducing the pressure behind leather washers, which are thus spread to fill the holes and prevent leakage of the fluid. This form of valve is built for the large area and low pressure service of the locomotive blowout type; as well as for hydraulic press service.

**PRECISION LATHE:** Frederick Pearce, 18 Rose St., New York City. This precision lathe was developed by the builders orig-

inally for their own use. It is intended to have the fine workmanship required by makers of delicate instruments, and at the same time to be capable of taking a reasonably heavy chip, considering the size of the lathe. The construction of the bed and slide rest departs from the usual lines, in that the carriage is mounted on ways at the front of the bed instead of on the top, while the tool rest is carried on a vertically adjustable slide on the carriage. This arrangement, besides furnishing an adjustment for the height of the tool, should also make of the machine a convenient precision miller for many varieties of work. Owing to the arrangement of the carriage ways, the carriage may be fed clear past the headstock to the head end of the bed.

**CLUTCH FOR IMPARTING VARIABLE SPEED TO MACHINES:** Variable Speed Clutch Co., Milwaukee, Wis. This clutch is intended not only for starting and stopping machines, but for varying the speed as well. In one form of the device the clutch members are thrown into contact by an air cylinder in which the pressure is maintained at a constant point by a reducing valve. The clutch levers are thrown out of engagement by the centrifugal action of revolving weights. When the speed of the driven member is so high that the weights fly outward against the air pressure, the clutch is relieved, thus setting the limiting speed of the drive. By varying the reducing valve adjustment this speed may be adjusted to any desired amount, giving more or less slip in the clutch. Another valve provides for throwing the air pressure on or off, thus starting and stopping the driven member. The clutch would seem to be the mechanical counterpart of the often conceived hydraulic by-pass arrangement for transmitting power at variable speed, and would apparently be subject to the same limitations.

\* \* \*

In the description of the Collis high-speed drill (made by the High Speed Drill Co., of Dubuque, Iowa) published in the new tools department of the December issue of MACHINERY, we inadvertently stated that with these drills, special holding chucks are *necessary*. This is, of course, a typographical error. It should have stated that special holding chucks are *unnecessary*.

\* \* \*

#### RAPID WORK WITH POWER HACK-SAWS.

An interesting test was recently undertaken at the E. C. Atkins & Co.'s plant, Indianapolis, to ascertain the cutting qualities of what is termed the A.A.A. hack-saw blades manufactured by the company, when used on the company's "Kwik Kut" power hack-saw. A piece of circular machine steel, 6 inches in diameter, was placed in the hack-saw machine and a cut was taken through the work in less than two hours, the machine being speeded up to fifty strokes per minute. The cut was true and straight so that no machining or planing was necessary. The machine was then slowed down to forty strokes per minute, and a second cut was completed in one hour and thirty minutes. A third cut was then made at the same speed, but with a five-pound weight added on the saw frame. This time the 6-inch diameter machine steel bar was cut through in one hour and fifteen minutes. In another test of the same hack-saw blades, in order to ascertain their durability, they were kept at work for thirty-two hours cutting annealed tool steel, and it was found that they stood up well for the work and were not entirely worn out. The accompanying half-tone shows the cuts made during the experiment, and illustrates the truth of the surfaces and straightness of the cuts taken.

\* \* \*

We are interested in all changes of positions of foremen, superintendents, shop managers and contributors, and request notices of such changes, and of deaths, for publication.



Rapid Cutting with "Kwik Kut" Hack-saws.

### THE CLEVELAND AUTOMATIC MACHINE CO.'S CHICAGO DEMONSTRATING ROOM.

The demonstration of the capabilities of automatic machine tools, perhaps, is more important than that of any other class of machine tools sold. The prospective customer first wishes to be assured that the machine will produce the parts desired true to size and shape, and with the required finish. He also wishes to be convinced that the machine can produce the work in the time specified, and to see with his own eyes the character of the tool equipment. Recognizing the desirability of accommodating "the man from Missouri," the Cleveland Automatic Machine Co., Cleveland, Ohio, last fall opened a demonstrating room at 67 West Washington Street, Chicago, in which are installed four working Cleveland automatic machines. These are the plain, three-holed, standard and new model designs, respectively.

The accompanying illustration shows the demonstrating room and the general arrangement of the machines. The machines, it will be noticed, are arranged *en echelon* on the plan generally followed in screw machine installation, that is, so the bar stock of one machine overlaps and parallels the next machine, and so on. This saving of floor space as compared with that required for the straight alignment generally followed with engine lathes is of much importance. The demonstrating room thus is made a model for automatic machine arrangement in installations for manufacturing.

All four machines are performing operations that are commonly regarded as extremely difficult. Customers can be shown the machines under difficult working without imposing on the hospitality of some good-natured manufacturer in whose plant similar machines are at work. Demonstrating rooms are not strictly a novelty in this country, but there are so few of them in which the machines are shown under full working conditions that the opening of this store is likely to attract considerable interest among the trade.

#### FIRST ALCOHOL MOTOR CAB IN NEW YORK.

The first alcohol motor cab has made its appearance in New York. It is the product of the factory of the H. H. Franklin Mfg. Co., Syracuse, N. Y., where the engineers have long been experimenting to provide an alcohol motor that would give results equal to those of the gasoline motor. The engine was tested over hundreds of miles of road before being sent out from the factory, and has demonstrated a capability of covering as great a distance for each gallon of alcohol as other motors of like size do for each gallon of gasoline. The new vehicle is of eighteen horse-power, and is identical with the gasoline motor cabs of the 1909 Franklin model except for the provision made for the use of alcohol in place of the gasoline. At first experiments were made with a regular gasoline engine, but after a study of its action an engine was made specially designed for alcohol, and it is this with which the new cab is propelled. Alteration is made as to compression and carburetion. The alcohol is found to produce no bad effect upon the motor. The problem of making a workable alcohol motor has been the subject of much atten-

tion on the part of the governments of France, Germany and the United States. The Franklin cab will now demonstrate its every-day practicability in competition with over 500 gasoline motor cabs of the landaulet type in New York City.

\* \* \*

#### LAST WIRE OF THE MANHATTAN BRIDGE CABLES STRUNG.

The last wire of the four cables of the new Manhattan Bridge across the East River, New York, was strung December 10 in the presence of Mayor McClellan, and other notable guests.



The Cleveland Automatic Machine Co.'s Chicago Demonstrating Room.

The improved method of stringing the cables, illustrated and described in the October issue of MACHINERY, has made the work proceed rapidly, 24,000 miles of wire having been strung in just four months. The span is 1,470 feet, or 130 feet less than the Williamsburg Bridge. The cables are 21¼ inches in diameter and each contains 37 strands of 256 wires each, making a total of 9,472 wires per cable. The wire is 0.192 inch diameter, No. 6 Roebling gage. Following the stringing of the wires begins the work of binding the cables together to shape them into cylindrical form to protect them from the elements. Miles of wire will be wrapped around them and hydraulic presses will be employed for pressing the strands together into the cylindrical shape of the completed cables.

\* \* \*

A clever device for making deadly revolver shooting at night possible by inexperienced shooters, has been patented that is worth attention because of the interesting principle involved. An electric flash lamp is mounted on the revolver barrel parallel with its axis, having a push-button located on the back end convenient for the shooter's thumb. Pressure on the button lights the electric lamp and projects a disk of bright light at a considerable distance, illuminating the object to be aimed at. In the center of the circle of illumination is a dark spot, this being the shadow of a tiny bead in the focus of the flash-light. This shadow marks the exact spot where the bullet will hit, and if the shooter can hold the shadow steadily on his victim he is assured of deadly aim. The attachment really makes it easier for a poor shot to hit an object at night than for a good shot to do accurate shooting by day-light.

## OBITUARY.



Geo. W. Corbin.

George W. Corbin, a prominent manufacturer and capitalist of New Britain, Conn., died at his home in that place November 30 in the fiftieth year of his age. Mr. Corbin had been in ill-health for a year or more, but up to a short time before his death appeared to be recovering, and then the end came suddenly. At the time of his death he was president of the Union Mfg. Co., the Corbin Brass Co., the Dean Steel Die Co., the Corbin-Church Co., the People's Savings Bank—all of New Britain, and for several years had been president of the Corbin Cabinet Lock Co. of the same place, resigning last May when ill-health made it impossible for him to attend further the duties of the position. His business career began in the employ of P. & F. Corbin, of New Britain, with which company he remained timekeeper until 1880. Mr. Corbin was a man of much personal popularity, and was made mayor of New Britain in 1894. He was prominent in the fraternal and patriotic societies, having acquired the thirty-third degree in the Masonic order and various honors in other societies. He is survived by a widow and four daughters.

Edwin H. Jones, president of the Vulcan Iron Works, Wilkesbarre, Pa., died at his home in that city December 2, aged sixty-four years.

Warren E. Hill, president of the Continental Iron Works, Greenpoint, Brooklyn, died December 8 of heart disease, aged seventy-four years. Mr. Hill was a member of the Society of Naval Architects and Marine Engineers, and the American Society of Mechanical Engineers.

## PERSONAL.

Henry Kerr has resigned his position with the Boston Gear Works, and has become connected with the New England Gear Works, Boston, Mass.

L. H. Mesker, who has been connected with the Motch & Merryweather Machinery Co. of Cincinnati is now connected with the Cleveland office of Manning, Maxwell & Moore.

Meldon H. Merrill recently resigned his position as salesman for the Westinghouse Electric & Mfg. Co., and has accepted a similar position in the Boston office of the Allis-Chalmers Co.

John L. Walker, formerly auditor for the Buda Foundry & Mfg. Co., has resigned his position, and has been made manager of the "Use-Em-Up" socket department of the American Specialty Co., Chicago, Ill.

Arthur Letherby, who for ten years has been superintendent of the Hamilton Machine Tool Co., has bought the interest of Mr. Philip Fosdick in the Kern Machine Tool Co., Cincinnati, Ohio, and becomes vice-president and superintendent. Mr. Letherby assumes his new duties January 1.

G. M. Basford, assistant to the president of the American Locomotive Co., 30 Church St., New York, has been made acting-secretary of the Railway Business Association. This association has been organized for the purpose of promoting confidence in railways and transportation interests generally.

Joseph A. MacLennan has resigned his position at the Philadelphia works of the Link-Belt Co. to become president of the Wilmot Machinery Co. of New Orleans. Mr. MacLennan was associated with the Link-Belt Co. for over twelve years, and lately was superintendent of the Philadelphia works. His early training was obtained in the erection department of the Wm. Cramp & Sons Ship & Engine Building Co., Philadelphia, Pa.

William P. Sargent, the author of the series: "The Design and Construction of Metal-Working Shops," now running in the engineering edition of this journal, goes with the Curtis Publishing Co., Philadelphia, on or about January 1, in the capacity of mechanical expert to investigate and suggest ways and means for solving the engineering problems that develop with a great publishing business. The company is building a new plant which will be completed in about two years, and it will be designed throughout for the economical production of its publications on a large scale. The circulation of its two journals now is over 6,000,000 copies per month, and plans will be made for the handling of a much larger circulation. The position is peculiar, the parallel of which probably does not exist anywhere else.

## JESSE M. SMITH.

Jesse M. Smith, the newly-elected president of the American Society of Mechanical Engineers, was born at Newark, Ohio, 1848. In 1862 he moved to Detroit, Mich., with his father's family, and in 1865 entered Rensselaer Polytechnic Institute, Troy, N. Y., remaining there three years. He traveled in Europe one year and then attended Ecole Centrale des Arts et Manufactures, Paris, three years and received the degree of mechanical engineer, therefrom, in 1872. During vacation periods he visited manufacturing plants in France, Germany and Belgium, and listened to lectures in the Polytechnic Institute of Berlin.



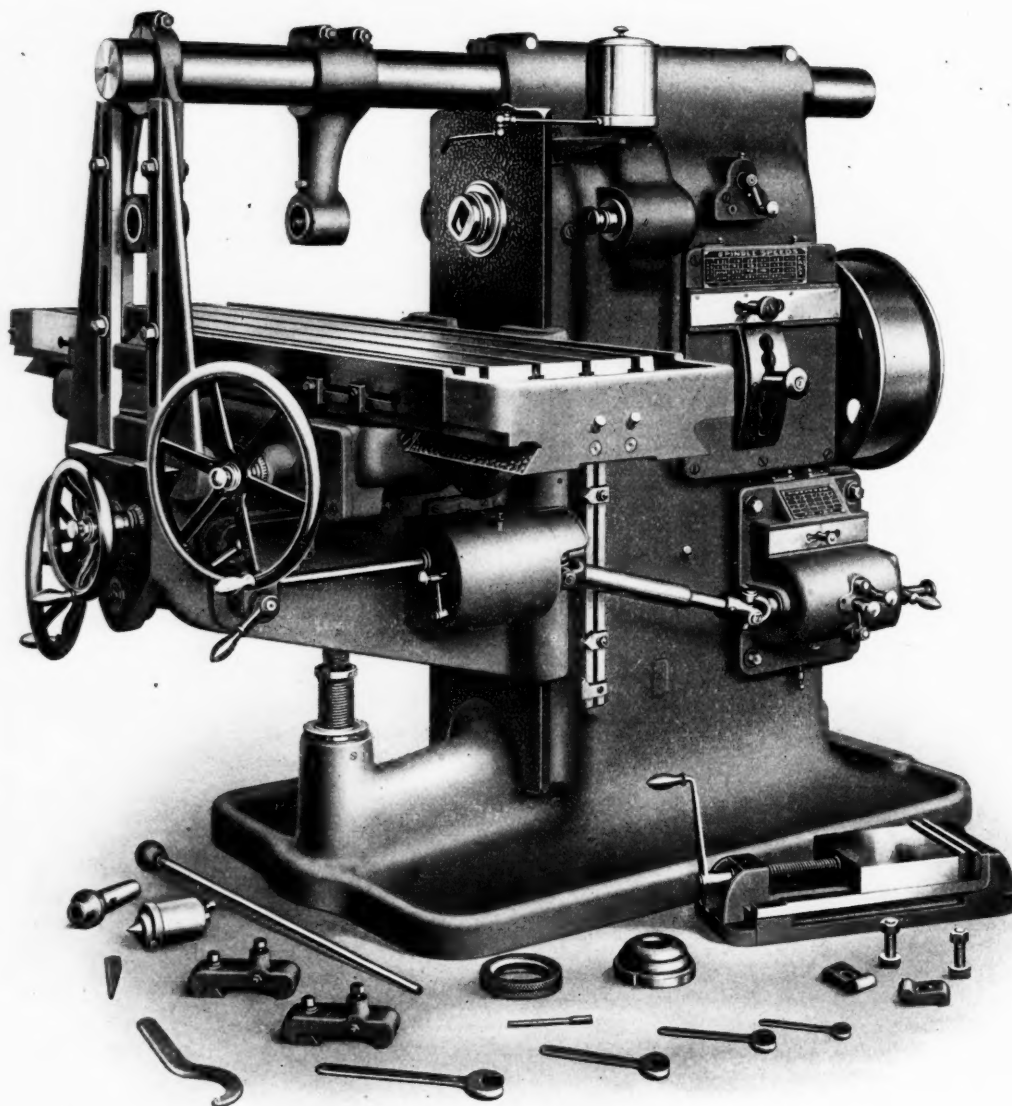
Jesse M. Smith.

Mr. Smith began the practice of engineering in 1873, designing and superintending the erection of blast furnaces for melting iron and native ores with the raw bituminous, in the Hocking Valley, Ohio. He also made surveys of coal mines, opened mines and built coal handling machinery for them and surveyed and constructed railroads from mines to furnaces. He represented the U. S. Electric Lighting Co. in Ohio and Michigan in 1884 to 1886, during which time he erected a number of early incandescent electric light plants, including one of 1,000 lights in the Stillman Hotel, Cleveland, Ohio, which was the first hotel lighted exclusively and continuously by electricity. Mr. Smith returned to Detroit

# Brown & Sharpe Mfg. Co.

PROVIDENCE, R. I., U. S. A.

Originators of the Constant Speed Drive Milling Machine



## No. 5-B HEAVY PLAIN MILLING MACHINE

Capacity

Longitudinal feed, 50", transverse feed, 12".

Vertical feed, 21". Feeds automatic.

MILLING MACHINES FOR HEAVY SERVICE

## Brown & Sharpe Mfg. Co.

PROVIDENCE, R. I., U. S. A.

### Experts in Milling Construction and Practice

Careful study of the requirements of milling machines for *Heavy Service* has produced the B. & S. Constant Speed Drive Milling Machine, an example of

#### POWER AND RIGIDITY

Attention is called

to the massive frame, its great width and depth and the large heavy base supporting it—The extreme vertical depth and large working surface of the table—The length and vertical depth of saddle—The rigid design of the knee which is strongly webbed on the inside and has exceptionally long bearings on the column—The stiff support of the overhanging arm—The driving pulley which is 20" diameter, takes a belt 7" wide and runs at the high speed of 320 R.P.M. developing *ample* and *constant* power for the heaviest cuts within the capacity of the machine—The massive spindle having a recess in the end instead of a slot across and supported by unusually long boxes of large diameter—The large diameter, wide face, and coarse pitch of all the gears—Both the speed and feed changing gears which are hardened, a feature, the value of which no authority will dispute—The lever type of tumbler gear lock which locks that gear rigidly and automatically as soon as the lever is released—The long and wide bearing surfaces accurately scraped and the rigid mounting of all shafts which are hardened and bushed with bronze.

Do these features not show a design of machine capable of developing power without undue stress in any of its parts?

when his father died in 1889 and opened an office as consulting engineer. He designed and erected several power plants and several plants for electric lighting and electric railways, and also apparatus for steam heating with exhaust steam in large manufacturing plants.

In 1883 Mr. Smith was called into service as an expert witness in patent litigation in the U. S. courts. This practice gradually increased, displacing his work as consulting engineer, until in 1898 he moved to New York City to continue the practice of expert in patent causes, exclusively. Among the notable cases of patent litigation in which he acted as an expert witness were: Steam injectors under the Hancock inspirator patents; cylinder lubricators for locomotives; quick-action air brakes under the Westinghouse patents; induction electric motors under the Tesla patents; incandescent electric lamps; cyclone dust collectors, roller mills and middlings purifiers for flour manufacture; pressure filters; steam heating apparatus; typewriters; calculagraph; armored concrete construction, etc.

Mr. Smith became a member of the American Society of Mechanical Engineers in 1883 and was a member of the council as manager 1891-94. He acted as vice-president 1894-96 and again, 1899-01. He is a member of the American Institute of Electrical Engineers, Societe des Ingenieurs Civils de France, Association des Anciens Elèves de l'Ecole Centrale des Arts et Manufactures, Detroit Engineering Society, Society for the Advancement of Science, American Geographical Society, Engineers' Club, and Ohio Society of New York.

### COMING EVENTS.

December 31-January 7.—Ninth annual show of the American Motor Car Manufacturers' Association at Grand Central Palace, New York City.

January 5.—First session of the fourth annual meeting of the Society of Automobile Engineers in New York City held in connection with the Automobile show at the Grand Central Palace.

January 12.—The next monthly meeting of the American Society of Mechanical Engineers will be held in the Engineering Societies' Building on Tuesday evening, January 12. The paper will be by Mr. Carl G. Barth of Philadelphia: "The Transmission of Power by Leather Belting," illustrated by lantern slides. It will be a comprehensive summing up of the theory and practice of belting in which conclusions are drawn from the work of Lewis, Bancroft, Bird and others, who have made experiments upon the transmission of power by belting. Valuable charts have been prepared by the author for the solution of belting problems. Mr. Barth's long experience in the scientific running of machine tools, in connection with the introduction of improved shop methods, has shown the need of definite data for the application of belting to machinery and led to the development of the results contained in his paper. His data have been applied to belting in different plants for many years, giving an unusual opportunity to study the problem in great detail.

January 16-23.—Ninth annual show of the Association of Licensed Automobile Manufacturers at Madison Square Garden, New York City.

January 22.—Final sessions of the fourth annual meeting of the Society of Automobile Engineers held in connection with the annual show at the Madison Square Garden, New York City.

June 16-18.—Annual convention of the American Railway Master Mechanics Association at Atlantic City, N. J.

June 21-23.—Annual convention of the Master Car Builders' Association at Atlantic City, N. J.

### NEW BOOKS AND PAMPHLETS.

REPORT OF THE COMMISSIONER OF EDUCATION, 1907. 522 pages, 6 x 9 inches. Published by the United States Bureau of Education, Washington, D. C.

RAILWAY CAPITAL AND WAGES. By W. H. Williams. Pamphlet of 22 pages, 8 x 10 inches, publishing the author's remarks before the Traffic Club of New York.

MECHANICAL WORLD, POCKET DIARY AND YEAR BOOK FOR 1909. 395 pages, 4 x 6 inches. Published by Emmott & Co., Ltd., 65 King St., Manchester, England. Price, 6d.

The twenty-second annual issue of the work contains a varied collection of notes, rules, tables and miscellaneous data for mechanics and engineers. The sections on steam turbines and friction clutches have been re-written and extended, and a section on chain drives introduced. A number of blank pages in the back part of the book provide for a diary and memoranda.

PRODUCER GAS, GAS FIRING AND THE ADVANTAGES OF GAS FIRING OVER THE DIRECT USE OF COAL. By Ernest Schmatolla. 16 pages, 5 1/2 x 8 1/2 inches. Published by the author, 317 High Holborn, London, W. C., England. Price, 1 shilling.

This pamphlet states the advantages to be derived from the use of producer gas in preference to that of fuel fed directly into the furnace; also information concerning the methods of utilizing fuels of inferior quality in specially constructed producers, so as to give results superior to high-class coal fired in the ordinary way.

MINE SAMPLING AND CHEMICAL ANALYSES OF COALS TESTED AT THE UNITED STATES FUEL TESTING PLANT, NORFOLK, VA., IN 1907. Bulletin 362. By John Shober Burrows. Published by the Department of Interior, U. S. Geological Survey, Washington, D. C.

Pamphlet giving location of coal beds and detailed sections of the seams at the points where the mine samples were taken, showing the amount of clean coal, and the partings of shale, bone coal, etc., together with chemical analyses of these samples and of the car-load lots as they were received at the testing plant after exposure to the weather for various periods.

ANNUAL REPORT OF THE CHIEF OF THE BUREAU OF STEAM ENGINEERING TO THE SECRETARY OF THE NAVY FOR THE FISCAL YEAR 1908. Published by the Navy Department, Bureau of Steam Engineering, Washington, D. C.

The report contains financial statement of expenditures for the year in the maintenance of navy yards, naval vessels, etc., purchase of

material and other incidental expenses, together with an account of the general operations of the Bureau, including a summary of the work done at the various navy yards of the United States, and a register of ships giving machinery data of all ships carried on the active list and those authorized by Congress and now under design or construction.

MORRISON'S SPRING TABLES. By Egbert R. Morrison. 84 pages, 6 x 9 inches. Published by Morrison and Martin, Sharon, Pa.

This book contains data on helical and elliptical springs, both heavy and light. The author has considered a helical spring whose bar is less than 1/16 of an inch in diameter, and an elliptical spring whose plate is less than 1/16 of an inch in thickness, to be a light spring. The tables give the length per inch of solid height; the weight per inch of solid height; free height per inch of solid height; and capacity. There are in addition formulas for calculating the properties of helical springs of round and rectangular section and elliptical springs. Mathematical tables are included to facilitate the use of the formulas.

FORGING. By John Lord Bacon. 112 pages, 6 1/2 x 9 1/2 inches. 178 illustrations. Published by the American School of Correspondence, Chicago, Ill. Price, \$1.00.

A manual of practical instruction in the hammering, working, forming and tempering of wrought iron, machine steel, and tool steel, including details of the modern processes of electric welding. The work contains throughout numerous illustrations which supplement and make clear the reference in the text. The chapter headings are as follows: Equipment; Welding; Calculation of Stock for Bent Shapes; Forging Operations; Simple Forging; Calculation of Stock for Forged Work; Tool Steel Work; Tool Forging and Tempering; Heavy Forging; Miscellaneous Processes; and Electric Welding Development.

THE APPRENTICESHIP SYSTEM IN ITS RELATION TO INDUSTRIAL EDUCATION. By Carroll D. Wright. 116 pages, 6 x 9 inches. Published by the United States Bureau of Education, Washington, D. C.

This is a work of valuable information concerning the industrial school problem. The need for a combination of the apprenticeship and academic education, and ways in which the combination may be effected, as shown by recent experiences in a few of our leading industries, are pointed out. The extent of the apprenticeship system in the United States and other countries is given, together with a description of various new apprenticeship systems which are the educational features of a few typical concerns in this country. Appended to the work is a digest of the apprentice laws of the various states.

ALGEBRA SELF-TAUGHT. By W. P. Higgs. 104 pages, 5 x 7 inches. Published by Spon & Chamberlain, 123-125 Liberty Street, New York.

Tenth edition of a volume for the use of mechanics, young engineers and home students. The contents of the book by chapters is as follows: Symbols and the Signs of Operation; the Equation and the Unknown Quantity; Positive and Negative Quantities; Multiplication, Involution, Exponents; Negative Exponents, Roots, and the Use of Exponents as Logarithms; Logarithms; Tables of Logarithms and Proportional Parts; Transformation of Systems of Logarithms; Common Uses of Common Logarithms; Compound Multiplication and the Binomial Theorem; Division, Fractions and Ratio; Geometrical Means; Limit of Series; Square and Cube Roots; and Equations.

MECHANICAL DRAWING AND ELEMENTARY MACHINE DESIGN. By John S. Reid and David Reid. 439 pages, 6 x 9 inches. 301 illustrations. Published by John Wiley & Sons, New York. Price, \$3.00, cloth.

This volume (second edition) is designed to apply the principles of mechanical drawing to the solution of practical problems in machine construction, and to familiarize the student with the arrangement and proportions of the most important machines and their details, and also the best practice in design and construction. The various chapters are as follows: Introductory Instructions; Screws, Nuts and Bolts; Keys, Cotter and Gibbs; Rivets and Riveted Joints; Shafting and Shaft-Couplings; Pipes and Pipe Couplings; Bearings; Sole-plates and Wall Box-frames; Belt Gearing; Toothed Gearing; Valves, Cocks and Oil-cups; Engine Details; Elementary Machine Drawing; Present practice in Drafting-room Conventions and Methods in Making Practical Working Drawings.

### CATALOGUES AND CIRCULARS.

FORT WAYNE ELECTRIC WORKS, Fort Wayne, Ind. Practical guide for transformer testing.

ALLIS-CHALMERS Co., Milwaukee, Wis. Bulletin 1513 on portable and stationary air compressors.

WESTERN ELECTRIC Co., 463 West St., New York. Bulletin No. 5370 on steam turbines built under the Rateau patents.

WESTERN ELECTRIC Co., 463 West St., New York. Booklets on design E and design L generators and motors.

AMERICAN BOILER ECONOMY Co., North American Building, Philadelphia, Pa. Catalogue of the Copes boiler feed regulator.

WESTERN ELECTRIC Co., 463 West St., New York. Booklet No. 1078 on magneto telephone wall sets, illustrating the construction.

WESTINGHOUSE ELECTRIC AND MFG. Co., Pittsburg, Pa. Circular No. 1157, descriptive of Westinghouse type "S" transformers.

GENERAL ELECTRIC Co., Schenectady, N. Y. Catalogue of motor generator sets, varying in capacity from 0.2 K.W. to 1,500 K.W.

INDEPENDENT PNEUMATIC TOOL Co., Chicago, Ill. Circular L of "Thor" pneumatic tools and appliances for metal working and wood working.

ARTISANS' GUILD, Benton Harbor, Mich. Catalogue of automatic oiler loose pulleys and automatic oiler sleeves for wood and large iron pulleys.

GENERAL ELECTRIC Co., Schenectady, N. Y. Catalogue of fan motors and small power motors, embracing both alternating and direct current types.

CLEVELAND TWIST DRILL Co., Cleveland, Ohio. Catalogue "Peerless" high-speed reamers in which the blades of high-speed steel are joined to the body by the "Brazo-Hardening" process.

CARPENTER STEEL Co., Reading, Pa. Pamphlet issued in commemoration of the Vanderbilt Cup Race, on the importance of alloy steels in modern automobile construction.

HYATT ROLLER BEARING Co., Newark, N. J. Leaflet entitled "Push Your Business with Less Friction," being an advertisement of the Hyatt anti-friction bearings.

FOLLANSBEE BROS. Co., Pittsburg, Pa. Catalogue entitled "Tin Truth" illustrating the manufacture of tin plate in the company's open hearth works and mills at Follansbee, Brooke County, W. Va.

G. M. YOST MFG. Co., Meadville, Pa. Leaflets listing solid jaw and swivel bottom machinists' vises, universal woodworkers' vises, "Uwanta" special railroad monkey-wrenches, blacksmith's leg vises, etc.

FOSDICK MACHINE TOOL Co., Cincinnati, Ohio. Circular illustrating and describing the Fosdick universal radial drills which are built half and full universal in 4-, 5- and 6-foot sizes.

NATIONAL-ACME MFG. Co., Cleveland, Ohio. Leaflet of new Acme automatic machine No. 515, which has a chuck capacity of 9/16 inch and a feed of 3 inches.

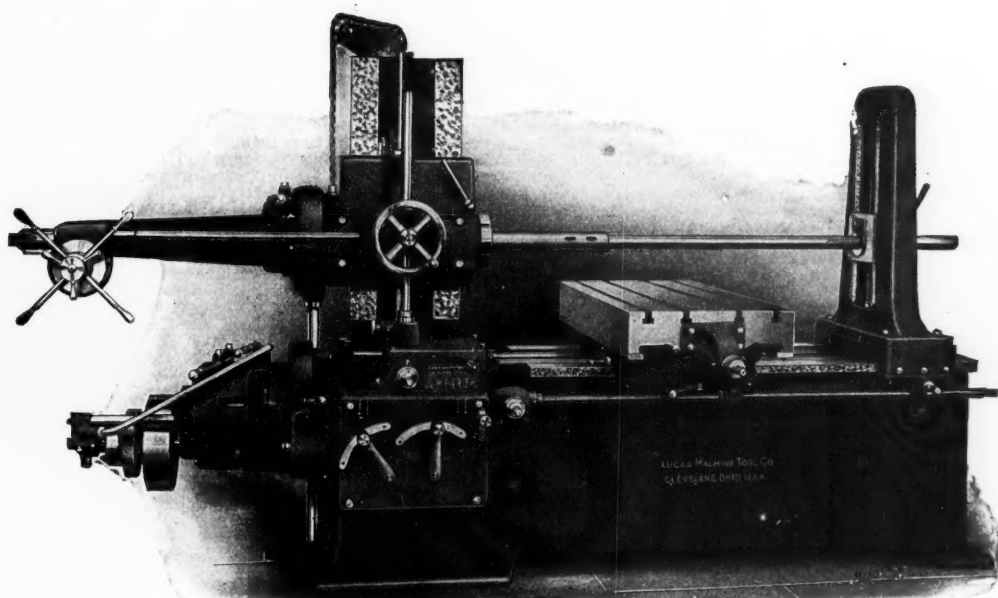
NORMAN W. HENLEY & SON, 132 Nassau St., New York. Catalogue of books for machinists, engineers, mechanics, mechanical engineers, inventors, foundrymen, electricians, draftsmen, etc.

W. H. NICHOLSON & Co., Wilkesbarre, Pa. Catalogue of Nicholson's inserted blade gas pipe taps, illustrated and described in this number. These taps are made in sizes from 1 to 12 inches inclusive.

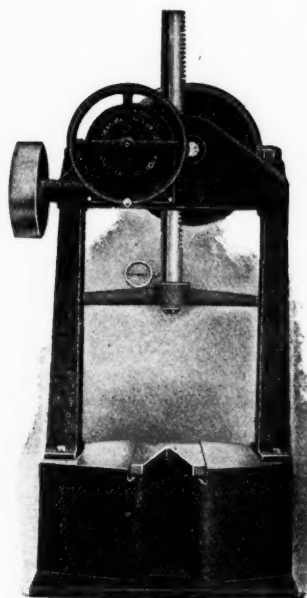
*You are making your own future every minute.*

Some day (if not now) you will need a boring machine, or a drilling machine, or a milling machine, or all three. Make your future bright by looking up the

**LUCAS (of CLEVELAND)**  
**"PRECISION"**  
**BORING, DRILLING AND MILLING MACHINE**  
**(NOT MACHINES)**



LESS ROOM, LESS INVESTMENT, LESS TROUBLE than these individual machines, and MORE WORK, BETTER WORK and NO RESETTING OF WORK.



**The Lucas**  
**Power Forcing Press**

Ram lowered, power applied, power controlled, power released, ram raised

ALL BY MEANS OF THE SAME WHEEL.

**Lucas Machine Tool Company**  
**Cleveland, O., U.S.A.**

EUROPEAN AGENTS: C. W. Burton, Griffiths & Co., London. Alfred H. Schutte, Cologne, Brussels, Liege, Paris, Milan, Bilbao, Barcelona. Schuchardt & Schutte, Berlin, Vienna, Stockholm, St. Petersburg, Copenhagen, Budapest.

**GREENFIELD MACHINE CO.**, Greenfield, Mass. Catalogue No. 3 of the Greenfield universal tool and cutter grinder. This handsome catalogue of 55 pages illustrates numerous applications of the grinder and methods of setting up for grinding all kinds of cutters, reamers, etc.

**BURY COMPRESSOR CO.**, Erie, Pa. Catalogue No. 40 of air compressors for general service. Built in a variety of styles and range of sizes from 6 x 6 inch to 24 x 14 inch air cylinder. The company also builds vacuum pumps.

**WESTERN ELECTRIC CO.**, 463 West St., New York. Bulletin No. 5113: Three Wire Generators L Design. This generator contains several points of special merit; it has only one slip ring, and no auxiliary apparatus whatever is necessary for operation.

**WARNER INSTRUMENT CO.**, 56-59 Roosevelt Ave., Beloit, Wis. Announcement of the new 1909 auto-meter for automobiles. This auto-meter indicates the rate of travel in miles per hour and records the total miles traveled for the season and for a trip, there being separate dials for the season and trips.

**NATIONAL TUBE CO.**, Pittsburg, Pa. Circular describing "Kewanee" air-pump unions recently put on the market for connecting locomotive air-pump pipes. This union makes the use of gaskets unnecessary, having a ball joint construction in which one part is brass and the other iron.

**YALE & TOWNE MFG. CO.**, 9 Murray St., New York. Catalogue of chain blocks, electric hoists, trolleys, cranes, winches, safety crabs, etc. The catalogue will be found valuable and interesting by all who are concerned with the problem of handling materials whether it be in the shop, foundry, warehouse or store.

**NATIONAL BRAKE AND ELECTRIC CO.**, Milwaukee, Wis. Catalogue No. 386, "Air Compressors for Industrial Purposes." These compressors are built to satisfy the demand for compact self-contained air compressors of reliability, and the design is based on the experience gained in the manufacture of air compressors for street railway service.

**NUTTER & BARNES CO.**, Boston, Mass. Catalogue of metal saw cutting-off machines and automatic saw sharpeners. The cutting-off machines are made in 4-, 6-, 8- and 10-inch sizes, with or without oil pumps or motor drives. The saw sharpeners are made in 20-, 30- and 3-inch sizes with various attachments. The 3-inch size is also adapted to sharpening milling cutters.

**BUFFALO FORGE CO.**, Buffalo, N. Y. Catalogue No. 197 describing the Buffalo fan system of heating and ventilating, containing four parts as follows: Part I. Heating and Ventilating of Public Buildings; Part II. Heating and Ventilating of Industrial Buildings; Part III. Buffalo Heating and Ventilating Apparatus; Part IV. Data on Heating and Ventilating.

**STANDARD ROLLER BEARING CO.**, 50th St. and Lancaster Ave., Philadelphia, Pa. Catalogue of 189 pages on ball and roller bearings made by the company, including illustrations and description of applications and considerable technical matter of general interest to users of ball and roller bearings. The catalogue lists the standard sizes of bearings manufactured.

**WILEY & RUSSELL MFG. CO.**, Greenfield, Mass. Catalogue No. 34 illustrating and describing full line of screw-cutting tools, machine taps, reamers, bolt cutters, etc. The catalogue contains many tables, rules and other data of general value to mechanics, machinists, repair men and all who have to do with metal working and the manufacture of machinery. This catalogue is sent to all on application.

**LAURENTE MICA CO.**, Box 911, Pittsburg, Pa. Pamphlet describing the advantages and uses of "Micanneal," a material for packing steel for annealing. It is claimed that this material is absolutely neutral, and that specimens of steel packed in it require from 25 to 150 per cent longer time to cool than in any other packing, thus insuring a better annealing effect.

**JAMES CLARK, JR., & CO.**, Louisville, Ky. Catalogue of Willey electrically-driven tools for metal working. These include portable drills and grinders, lathe carriage and tool-post grinders, bench grinders, floor wet and dry grinders, friction-driven sensitive drills, upright drills, multiple spindle drills, semi-radial and radial drills, hack-saws, notching presses, etc.

**UNITED ENGINEERING AND FOUNDRY CO.**, Pittsburg, Pa. Catalogue of rolling mill machinery, including rolling mills, roller tables, manipulators, hydraulic shears, plate shears, rail straightening machines, horizontal beam straightening machines, roll turning lathes, squeezers, galvanizing machines, corrugating machines, rail cambering machines, tube works machinery, steel castings and gears, etc.

**CALCULAGRAPH CO.**, 9 Maiden Lane, New York. Pamphlet by Nelson W. Jarvis entitled: "Telephone in Factory Cost Accounting." The pamphlet illustrates the use of the telephone in large manufacturing plants to reduce the labor of cost accounting and to keep the cost accounting department in constant touch with every department of the plant. The system has been developed in connection with the calculagraph, and the pamphlet will be found of much interest to all concerned with large problems of cost accounting.

**HILL CLUTCH CO.**, Cleveland, Ohio. Catalogue G of friction clutches, of which two types are made by the company. These range in sizes from 12 inches diameter, having a capacity of 5 H.P. at 100 R.P.M. to 84 inches diameter with a capacity of 1,300 H.P. at 100 R.P.M. While the Hill 1907 standard clutch illustrated is the same in principle as built by the company for the past twenty-two years, the construction embodies a number of important improvements recently made. The Hill positive action clutch is a development of the standard clutch, embodying the salient valuable features of the standard clutch.

**MANNING, MAXWELL & MOORE**, 85-89 Liberty St., New York. Catalogue of Hancock valves manufactured by the Hancock Inspirator Co., a constituent company of Manning, Maxwell & Moore. The Hancock valves are made of bronze, cast iron, and steel, the principal line being bronze globe, angle, 60-degree and cross valves in sizes up to 3 inches. The hand-wheels are of open pattern to which the name "zero" has been applied because of their tendency to stay cool even with high steam temperatures. The valves for superheated steam are made with steel bodies and for pressures up to 500 pounds. Iron body valves are made for steam pressures up to 175 pounds.

**WESTINGHOUSE ELECTRIC AND MFG. CO.**, Pittsburg, Pa. Westinghouse Diary for 1909. This popular publication was first issued in 1905, and immediately became popular because of the large amount of technical matter contained in small space, much of which is not readily available elsewhere. The 1909 edition includes matter on high-pressure steam turbines, Leblanc condenser, low-pressure steam turbines, mechanical stokers, mercury vapor lamps, meter testing, storage batteries, single-phase railway lamps, turbo pumps and blowers, etc. The diary is particularly valuable to travelers, containing accurately engraved colored maps of the United States, Panama, Cuba, Philippine Islands, Hawaii, Eastern and Western continents. The list of representative hotels in the United States will be generally appreciated. The diary measures 2 3/4 by 5 1/2 inches, and thus is of convenient pocket size.

**S. OBERMAYER CO.**, Cincinnati, Ohio, will issue a series of twelve colored post cards, illustrating the wonderful part that iron and steel have played in the history of the world. The first card shows Tubal Cain, the first iron worker of history who lived about thirty-five hundred years before the Christian era, forging a crude spear. The second card depicts Pharaoh's chariots, and in the third Hiram of

Tyre is shown casting a column for King Solomon's temple. These columns were 27 feet long, 4 feet 6 inches diameter, and weighed 175 tons. The work of the Romans in iron and bronze follows, and then: "The First Iron Plow," "The Battle of the Ironclads," "The Bread Giver of Nations" (the self-binding harvester), "The Modern Steam Engine," "Changing the Map of the World by Digging the Panama Canal," "The End of War," "New Manhattan Suspension Bridge," and the proposed Equitable Life Insurance Building, which will be sixty-two stories or 909 feet high, etc. This series will be sent free to anyone connected with the iron and steel industries.

## MANUFACTURERS NOTES.

**TRIUMPH ELECTRIC CO.**, Cincinnati, Ohio, has made contracts for the erection of a new factory.

**BARTZ, WYGANT & BROWN**, manufacturers of electric generators and motors, have erected a four-story office building, 36 x 72 feet.

**MARSHALL & HUSCHART MACHINE CO.**, 62-66 South Canal St., Chicago, Ill., has completed an interesting new store and salesroom for machine tools and kindred products.

**F. BISSELL CO.**, Toledo, Ohio, is planning a new shop for the manufacture of switchboards and panel boards for electric lighting and power plants. A traveling crane will be required.

**G. M. YOST MFG. CO.**, Meadville, Pa., reports that its business is growing, and that new machine tools were recently installed to meet the demand for its vices, wrenches, etc.

**H. C. KARLSON**, 39-41 Cortlandt St., New York, whose large table of decimal equivalents was noted in the December issue, was erroneously located on Fulton St., the correct address being as above.

**HEERESHOF MOTOR CO.**, Detroit, Mich., will begin the manufacture of automobiles in the near future, and it desires catalogues of machine tools and machine shop equipment used in automobile factories.

**KERN TRADING OIL CO.**, Bakersfield, Cal., is about to erect a large machine shop and warehouse on its property at Coalingo, Cal., where it will develop oil wells to supply the Southern Pacific Railroad with fuel oil.

**S. F. BOWSER & CO., INC.**, Fort Wayne, Ind., has just completed a new two-story cement block building 50 x 100 feet which is to be used for the accommodation of its salesmen, as a sample room, and for the drafting and experimental departments.

**WHITING FOUNDRY EQUIPMENT CO.**, Harvey, Ill., recently equipped the new plant of the American Car & Foundry Co., at St. Louis, Mo., with wheel pits, pitting trolleys, electric puller machines, floor cranes, reservoir ladles, teapot spout wheel pouring ladles, etc.

**MANUFACTURERS' ASSOCIATION OF CORRY, PA.**, was organized December 5, and officers were elected. The president is F. E. Whittlesey (secretary Raymond Mfg. Co.), and secretary and treasurer, Arthur J. Lyons (secretary and manager U. S. Chair Co.).

**DAVIS MFG. CO.**, Milwaukee, Wis., has built a brick shop 100 x 150 feet, with concrete floor and steel roof trusses supporting saw-tooth roof. The new plant is expected to be ready for operation about January 15. Machinery will be grouped and driven from line-shafts by individual gas engines made by the company.

**ONEIDA STEEL PULLEY CO.**, Oneida, N. Y., manufacturer of steel pulleys, is prepared to make steel pulleys in all commercial sizes up to 112 inches diameter, 40 inches face, and 1 to 8 inches bore. It recently shipped a steel pulley 108 inches diameter.

**WELLS BROS. CO.**, Greenfield, Mass., has remodeled its plant for manufacturing taps, not having built an entirely new plant as was intimated in the note published in the December issue. A description of the plant and methods of manufacture appears in another part of this issue.

**PETER A. FRASSE & CO.**, 94 Fulton St., New York, has opened a branch office and large warehouse at 50-52 Exchange St., Buffalo, N. Y., where a full line of steel tubing, tool steel and other steel specialties will be carried. The new warehouse covers 10,400 square feet of floor surface.

**NATIONAL GAS AND GASOLINE ENGINE TRADES ASSOCIATION** was organized in Chicago, December 9, Henry T. Wilson, Middletown, Ohio, being made president, and Albert Strimatter, Cincinnati, Ohio, secretary. Free charter membership in the organization closes April 1, 1909, after which the initiation fee will be \$10. The annual dues are \$5.

**ACME MACHINE TOOL CO.**, Cincinnati, Ohio, has been incorporated with a capital of \$100,000 to manufacture machine tools. Mr. C. H. M. Atkins is president and Mr. J. H. Williams is secretary and general manager. The company will occupy the present buildings of the Cincinnati Planer Co. at Spring Grove Ave. and Buck St., and expects to begin operations about February 1st.

**SCHUCHARDT & SCHUTTE**, the well-known machinery house of Berlin, Vienna, Stockholm, St. Petersburg, Copenhagen, Budapest, London, New York and Shanghai, has opened a branch under the firm name for the sale of machine tools, woodworking machines and small tools at 14 Akashicho Tsukiji, Tokio, Japan. The Tokio branch office is under the management of Mr. James G. Brown, who has represented the firm several years in the far east.

**FIRTH-STERLING STEEL CO.**, McKeesport, Pa., has received through its Chicago agents a report of remarkable endurance of "Blue Chip" saw tooth dies used in the manufacture of saws by E. C. Atkins & Co., Indianapolis, Ind. The dies are used under a drop-hammer, weighing 600 pounds and falling 20 inches, and the dies average 40,000 saw teeth, two teeth to the set, or 20,000 sets. Heretofore dies made of other steels have averaged only 4,000 to 6,000 sets, the increase in output thus being over 500 per cent.

**CROCKER-WHEELER CO.**, Ampere, N. J., has erected a bronze and tile memorial tablet in honor of the French scientist, Andre-Marie Ampere, who founded the science of electrodynamics, and whose name is used throughout the world to designate the unit of electric current. The tablet was unveiled December 3 in the presence of a distinguished company, by the French ambassador, Jules J. Jusserand. Ampere is the only place in the world named after this distinguished Frenchman, and the tablet probably is the only memorial raised in his honor in America.

**CLEVELAND CRANE AND ENGINEERING CO.**, Wickliffe, Ohio, reports that it has experienced considerable improvement in its business lately, having recently shipped several large cranes to navy yards and other United States Government works, as well as to private concerns. Among these are two 10-ton 3-motor 40-foot span alternating current cranes for the Puget Sound Navy Yard; one 10-ton 3-motor 40-foot span crane for the New Orleans Navy Yard, and two 20-ton 3-motor cranes to the Isthmian Canal Commission for Panama power houses. Other cranes are under construction and inquiries are improving. The present outlook is bright for 1909 business.

**CLEVELAND MACHINE WORKS**, Cleveland, Ohio, was recently organized for the manufacture of constant-speed-drive horizontal power drilling and milling machines, and the machine shop erected at 1519 E. 32d St. has been equipped with modern tools for their manufacture. Messrs. J. G. Bellinger and Fred. W. Bowler are associated in the company. Mr. Bellinger has been for many years well-known as the designer and builder of automatic machinery and special tools, and Mr. Bowler is well-known in and about Cleveland as a machine tool salesman. The company expects to have machines on the market in February or March. It will sell through dealers.

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